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October 23, 1926

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By Arthur Barrette Parsons

Primitive Mining and Metallurgical Methods - III
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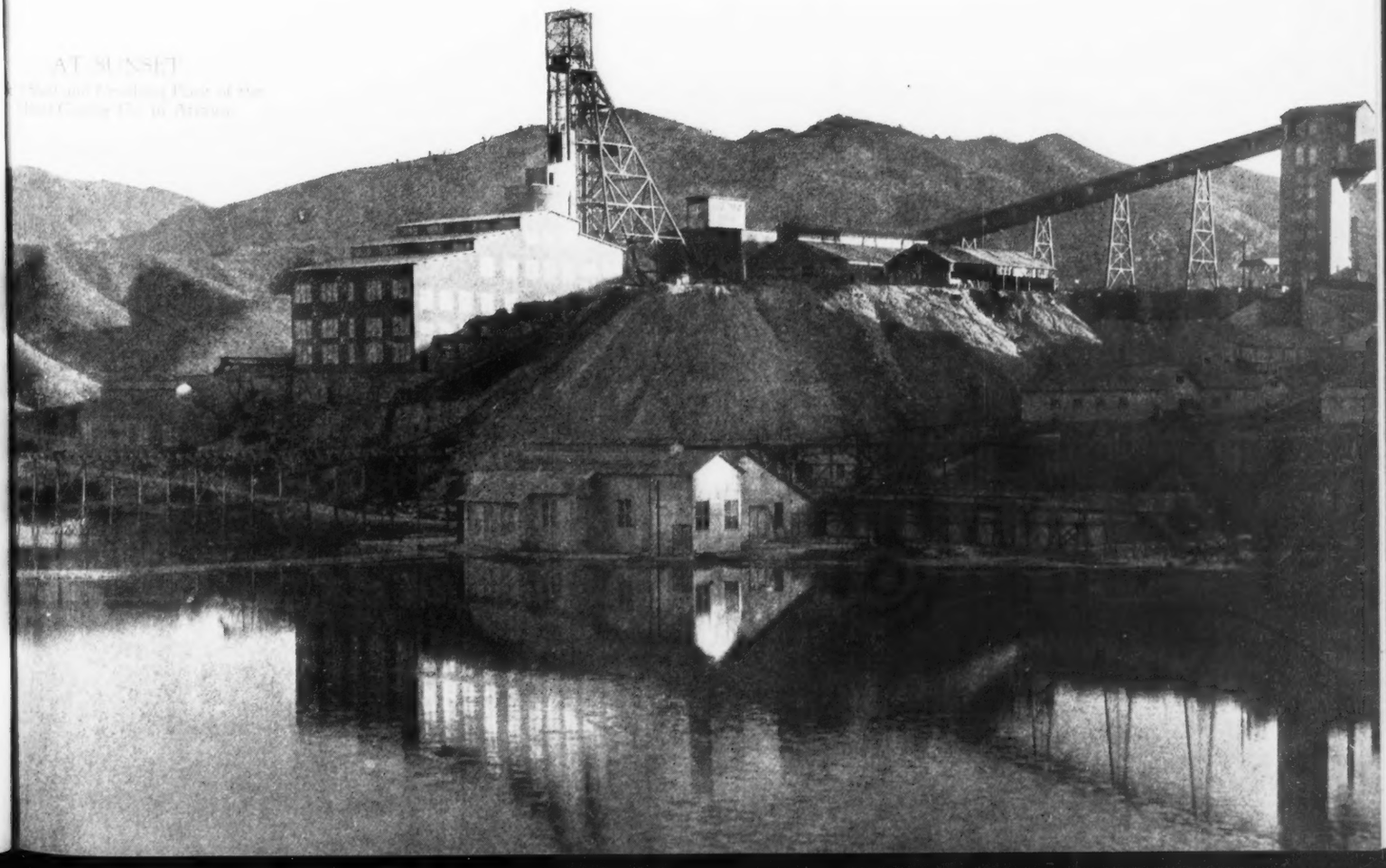
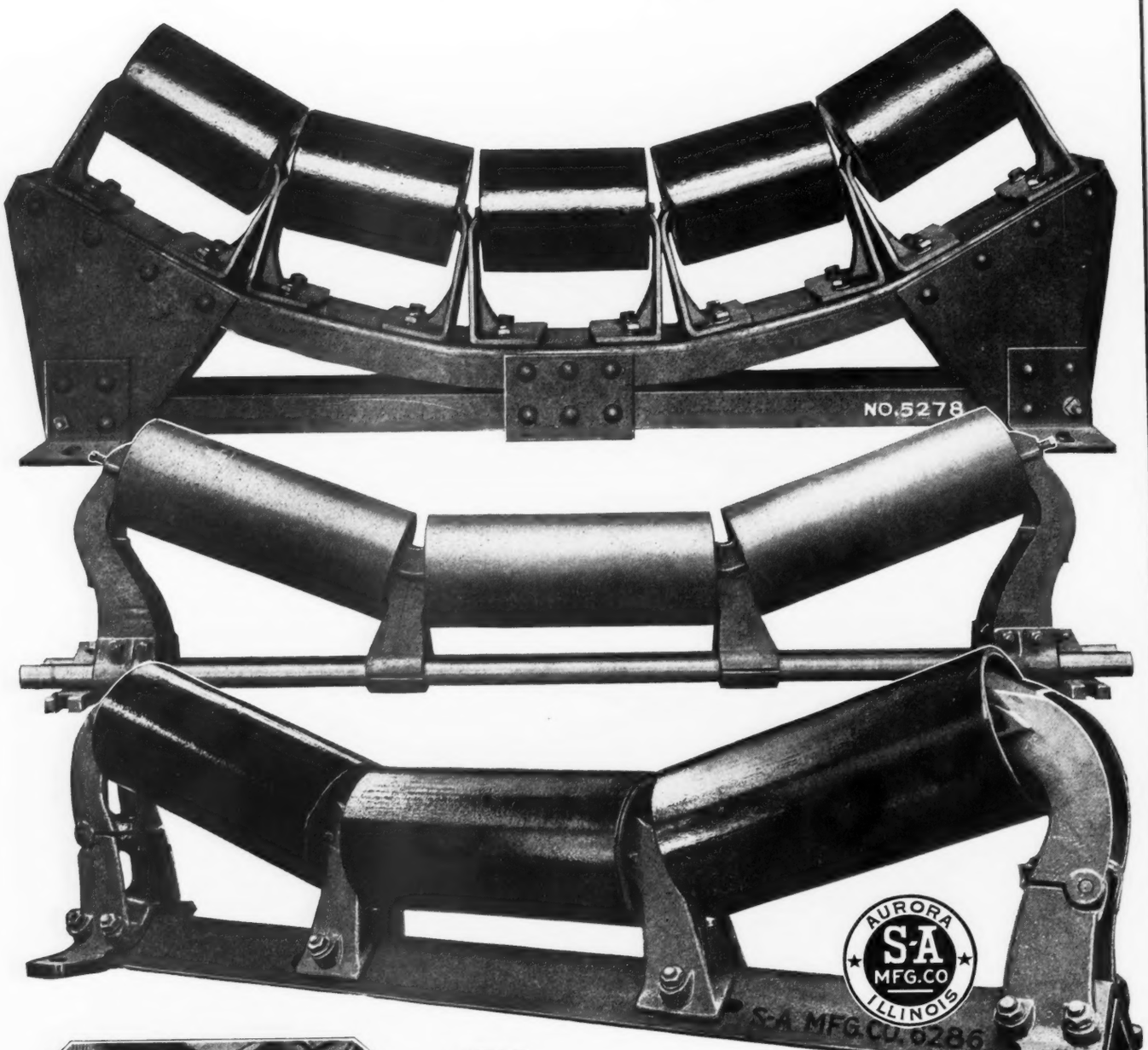
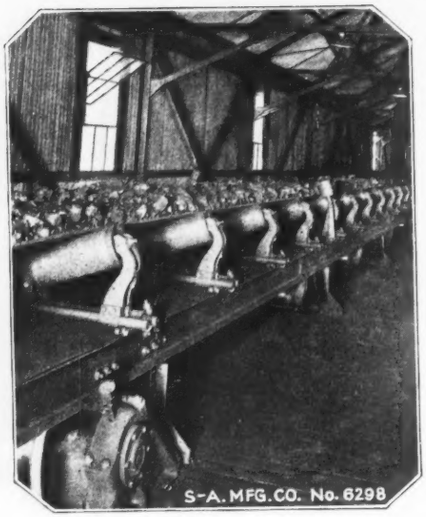
Methods and Costs of Shaft-Sinking at Victor, Colo.
By A. F. Carper

A Gold-Antimony Mine in France
By Henry Briggs

The Spokane - Kimberley Institute Meeting







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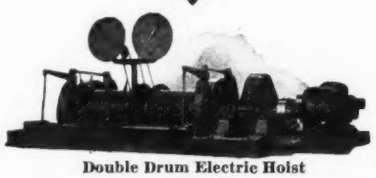

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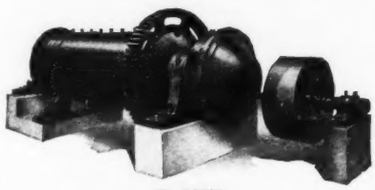

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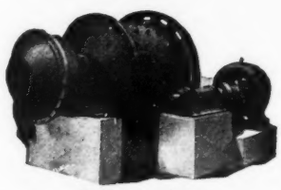

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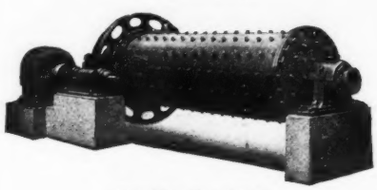

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ENGINEERING AND
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JOSIAH EDWARD SPURR, Editor

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The White Man's Burden

NEARLY ALL of the world's mining is done by nations of European stock—pre-eminently by Americans and Britons, secondarily by the nations of Western Europe. Asiatics have generally submitted or appealed to these natural mining peoples for the exploitation of the ores within Asiatic domains. Even in Europe, the Russians, of more direct Asiatic stock, have depended mainly upon Western Europeans —and, lately, Americans—to conduct their mining operations.

The underlying reason for this is partly temperamental, partly, in the last analysis, religious, of which reasons the second may be the consequence of the first, and the first the consequence of social conditions due to effete and long-seasoned civilizations. In general, the Asiatic religions are resigned, or fatalistic. What is, was always so ordained: therefore resignation and apathy, not struggle for change, is the best course. Since this life is the expression of the unseen higher powers, all circumstances and materials are relatively unimportant, since unreal and transitory. The Oriental does not highly esteem the fact, but the unseen super-powers: hence all the religions of the world are Asiatic, including Judaism and Christianity. The Occidental has always been practical, putting the fact foremost, with an intense curiosity to study natural laws: thus the development of science, beginning in Greek and Roman days and flowering in Europe and America in the present day. The so-called conflict between religion and science is indeed the conflict between Asiatic mysticism and Occidental pragmatism. The Occidentals embraced Christianity, but do not practice it; but the Asiatics practice their religions in every detail. Mining is a science, and a necessary preliminary to the development of most of the arts; and hence not only the Occidental urge for metals but the knowledge of how to win them. The most practical, materialistic, and scientific of nations as a general rule make the most aggressive and successful miners.

It is interesting to consider further the relation of these fact-respecting ancient European traits to the European social and ethical conceptions. The older idea of a gentleman, that he should learn "to ride, shoot, and speak the truth," would not be understood in any of its divisions by the typical Oriental. Since facts are dreams, they may be disregarded in speech. Perhaps the most popular virtue of our day is truth-telling, which the tradition and nature of the average man insists on more strongly than does his religion. Upon this fundamental racial regard for the truth, indeed, all our science and progress are based. The humorist who defined a mine as a hole in the ground owned by a liar did not correctly define the real miner, who is successful in proportion as he sticks to hard facts. Indeed, one must class the originator of this *mot* with the one who defined a mining expert as "a —— who wears yellow boots," and monzonite as "an igneous rock controlled by the Guggenheims."

Copper Exporters

COPPER EXPORTERS, INC., is more than an association of American copper producers exporting copper under the Webb Act. With its control of copper in the United States through its member companies, it joins the co-operation of the principal foreign producers of copper in the world—Mexican, Canadian, German, French, Spanish, South American, and Belgian (African). The Japanese copper mines do not appear in the list, although Japan is the fourth copper-producing country: nevertheless, it is probable that Japan would join if the occasion came. Japan exports little copper, but is nevertheless one of the factors in world trade, and probably could produce more if the price should go up.

While this is strictly an association to operate outside of the United States, its stabilization of markets in foreign countries might conceivably affect prices inside of this country. Just how great will be the success of this enormous combination will be for the future to foretell. Its formation is in line with the trend of the times—whereby the old national cartels and combines will be expanded to world-wide organizations. The world has shrunk so nowadays that nothing short of world study of a commodity, and consideration of world regulation, is worthy the attention of real captains of industry. Announcement of the organization followed closely on the heels of that of the iron and steel trust in Europe, wherein, as in the present instance, producing interests in several countries united for their common welfare.

Undoubtedly the ultimate objective of the copper combination, like that of similar organizations, is a better price for copper. This can probably be maintained through the elimination of destructive bidding competition and broker speculation. Nevertheless, there is little danger that prices can be raised so high as to become a hardship to the consumer. There are substitutes for many of the uses of copper, and the red metal will have to fight its way in competition with others—such as aluminum, of which the world marketing is similarly controlled. Indeed, in the effort to create expanded consumption, such controls as this often operate to lower the price, a procedure made possible by the saving in marketing and distribution expense through system and co-operation.

Of course, it is too early yet to note any of the practical effects of the move. A slight advance was noted in the London market, but this reflected little more than a scurrying to cover on the part of the dealers,

many of whom had apparently formed the opinion that the export plan had been indefinitely postponed. Copper, naturally, will be harder for them to get, but, on the other hand, demands from their customers will be less if the export association sells direct on acceptable terms. A slight hardening also occurred in the New York market, but consumers showed no great rush to buy and evidently feel that no great misfortune will come to them if they continue in their habit of buying as they need the metal.

Earthquakes Under-ground

HUMAN NOTICE of an earthquake is measured by its effects on mankind. When a violent earthquake takes place in a desert area, it is entirely unnoticed in the newspapers; when it occurs in an area of sparse population, it does little damage, and makes no history: but when it shakes a great city, like Charleston, San Francisco, or Tokio, its magnitude looms up in the popular mind. On June 27, 1925, there occurred an earthquake of the first magnitude in Montana, whose movement was noticed over an area of 310,000 square miles. Due to the comparatively sparsely settled nature of the region, and the low dwellings and public buildings characteristic of ample space, the damage done was slight. One church was wrecked, some school houses were badly damaged; and some damage was done to buildings for a distance of 75 miles from the epicenter, or point where the movement was greatest. Overhanging cliffs and poised boulders were shaken down. No people lost their lives, owing to the public buildings being vacant at the time of the quake. These and other effects of the earthquake are explained in Professional Paper 147-B of the U. S. Geological Survey, by J. T. Pardee (published Sept. 20, 1926).

The minor effects on human beings were amusing. A man who had raised his foot to step over a ditch was unable to change this pose for a few seconds, whereupon he fell into the ditch. In the excitement, one woman at Butte laid down her baby and picked up the cat—it is said. Probably the cat was a valuable one. Within a large area nearly everyone experienced a dizziness or nausea.

What interests miners most is that the workings of mines were not damaged. "Contrary to a rather widespread apprehension, the workings of mines were not damaged by the earthquake, and in fact the shock was not generally noticed by the miners who were underground at the time. At Barker a group of miners who were at work in a stope at a depth of 250 ft. did not feel the shock, though it was generally noticed in that neighborhood by persons at the surface. So far as learned, the thousands of miners at Butte who were under-ground at the time were generally unaware that an earthquake had occurred. In view of the fact that mine workings are generally constructed so as to stand the jars from blasting, it is not surprising that they would resist damage by the less violent vibrations of this earthquake. Owing to the common occurrence of the jars caused by blasting, miners at work would not be likely to notice especially the somewhat similar vibrations of seismic origin. Furthermore, as these vibrations are less destructive in areas of solid rock than in loose materials, they would be less noticeable underground than at the surface."

This observation is most interesting, since it corresponds to the observations made on the Tokio earthquake as recorded in our editorial of July 11, 1925. Mr. Pardee's explanation assumes that the quake was as violent under-ground as at the surface, a conclusion which the recorded phenomena made doubtful. The nature of a mine blast is far different from the rolling, twisting motion of an earthquake, which is instantly recognized even where movement is slight. Had the rocks under-ground suffered the same movement as took place at the surface, the mine workers in Montana and in Japan, must, it seems, have noticed it. Moreover, such a violent shaking down of all unpoised and all unsecured materials and blocks as occurred at the surface would have had a very noticeable effect in mine workings, had a corresponding motion taken place. At the surface, the recorded movement is a twisting or a rocking one, which in Tokio showed itself, in the larger buildings, by the breaking of all windows at a certain story, while windows above and below were unbroken; or by the twisting of monuments on their pedestals. At Logan, Mont., chimneys of a one-story house were similarly twisted on their bases without being shattered. The rocking movement, probably due to actual earth waves at the surface, was shown in Montana by objects like telegraph poles and automobiles, which leaned one way and then the other, describing arcs of as much as 30 deg. Such surface motions as these are evidently less at the surface; greater at a little distance above it, on persons, buildings, or objects which extend up away from the surface. The rocking described is like that of a rolling ship, due to waves which pass over the surface of the ocean, but are progressively less in depth, and soon die out. Such rocking as this would certainly have demolished many mine timbers had it been present in the mines. But the described surface phenomena showed that the axis of these swings was at the surface itself. The damage done to buildings by the twisting motion is also plainly due to the fact that the jerk is far greater at a certain distance from the surface at which it apparently originates.

All this leads to the suspicion that earthquakes are more pronounced at the surface of the earth than they are at a very little depth; that earthquake waves, in their known manifestations, may be mainly superficial phenomena, due to the release of subterranean rock vibrations, at the surface—vibrations which underground are transmitted with little translation into motion. It seems, indeed, questionable, if we depended upon under-ground phenomena, whether the earthquake would have been recognized at all, as an important type of disturbance.

A Silver Mine in Mississippi—No Cause for Alarm

THE ANNOUNCEMENT of the discovery of an enormous silver-lead deposit near Fulton, Mississippi, as made in the *Age-Herald* (Birmingham, Ala.), Sept. 25, 1926, should not be taken too seriously. If true, one might expect a further drop in silver prices and at the same time postpone the pending lead shortage at least ten years. The announcement reads as follows:

"A mine of galena of sulphate of lead has been discovered in this vicinity, it was announced today by W. A. Hamby, former member of the United States Geographical Survey, and samples are being exhibited to support the assertion. Analysis of Mr. Hamby's samples show 30 per cent silver, 30 per cent lead, and the balance in galena, it was further learned. The vein is six feet in depth and

extends two or three miles in length, according to Mr. Hamby. Borings indicate that the vein is about one mile wide. In the event that the ore stands up to the analysis, the mine will yield more than 2,000,000 tons of pure silver, Mr. Hamby reports."

In the first place, the mine contains "galena of sulphate of lead," whatever that may mean. Mr. Hamby is a former member of the United States Geographical Survey, presumably meaning the United States Geological Survey. With these distorted statements standing out so boldly, one may reasonably question the assay value and silver reserves.

Two million tons of pure silver would satiate the monetary desires of many an Indian prince.

What We Face

DURING THE WORLD WAR it was difficult for a contemporary to realize the magnitude of world events, the crushing of empires, the colossal slaughter. And it is likewise difficult to grasp the significance of the immense industrial and social changes that are taking place, for we are in them, and can get no perspective. Science, unleashed, has thrown itself into the harnessing of the forces of nature for man's use—for the development of complex machinery and other devices to save his labor and minister to his pleasures. But as these increase, the desires of mankind, equally without restriction, keep pace. Rest nor leisure does not result from the railroad, the telegraph and telephone, the smooth highways and the automobiles—indeed the human tension is geared higher than ever before, and our cities become pandemoniums of shrieking machines and hurrying and jostling men and women. Methods of government are changing, undergoing a perplexing development. Monarchies are overthrown; democracy on the other hand is abandoned for dictatorship by groups or by natural leaders, like Mussolini in Italy, Pilsudski in Poland. Old-time democracy, like that possible when the United States was formed, appears now infeasible. Will Durant, author of "The Story of Philosophy," writing in *Harper's Monthly*, refers to the change most strikingly:

"National isolation is gone, because of trade communication, and the invention of destructive mechanisms that facilitate invasion. Personal isolation is gone, because of the growing interdependence of producer, distributor, and consumer. Skilled labor is the exception now that machines are made to operate machines, and scientific management reduces skill to the inhuman stupidity of routine. Free land is gone, and tenancy increases. Free competition decays; it may survive for a time in new fields like the automobile industry, but everywhere it gravitates toward monopoly. The once independent shopkeeper is in the toils of the big distributor: he yields to chain drug stores, chain cigar stores, chain groceries, chain candy stores, chain restaurants, chain theaters—everything is in chains. Even the editor who owns his own paper and molds his own mendacity is a vestigial remnant now, when a thousand sheets across the country tell the same lie in the same way every day better and better. An ever decreasing proportion of business executives (and among them an ever decreasing number of bankers and directors) controls the lives and labors of an ever increasing proportion of men. A new aristocracy is forming out of the once rebellious bourgeoisie; equality and liberty and brotherhood are no longer the darlings of the financiers. Economic freedom, even in the middle classes, becomes rarer and narrower every year. In a world from which freedom of competition, equality of opportunity, and social fraternity have disappeared, political equality is worthless, and democracy becomes a sham.

"All this has come about not (as we thought in our youth) through the perversity of men, but through the impersonal fatality of economic development."

Sir Oliver Lodge, great scientist as well as mystic, sees no human progress—that is, progress of man as an individual, in the matter of world "improvements"; and many foreigners see in a great center like New York a lack of repose, spontaneity and joy, a dwarfing of creative intellect, and a deadly socialization. Henry Ford pays high wages, and advocates a five-day week; but the officials of the American Federation of Labor who visited his factories were of the opinion that the highly efficient working system which made this possible sucked dry and ruined early the lives of the workers.

The multiplicity of mechanical slaves, vastly increasing per capita production, becomes the problem—therefore salesmanship is the burning issue of the day—how to make a man use as much more than he needs as possible. Eventually, however, it is believed that this effort must be checked—consumption will be more limited than production; and the result will be fewer hours of work, more leisure—but for what? For culture, repose, meditation, relaxation? The very spirit of the age is against this. The highly geared worker must take his pleasures in the way he is trained to work, with as little personal thought, with as much tenseness and speed.

There are thus two classes of problems to be studied in connection with the march of events—the social problem and the individual question. As to the former, there is little doubt that the world is becoming increasingly organized along economic lines and accordingly increasingly socialized. As to the individual, he is losing out. The entire subordinating of the individual to society seems to be swiftly taking place—it is preached and practiced in such diverse and mutually inimical countries as Russia and Italy. The Fascist press, in connection with the assumption by Mussolini of the complete control of the soldiery, hails with approval the passing of the liberty of the individual.

Men, at this juncture, should study the history of the insects—the ant and the bee, for example—and perceive how the chances for further evolution depend upon the development and differentiation of the individual; and how standardization and socialization may arrest and forever freeze the progress of mankind. Nevertheless, this will probably not happen. Undreamed revolutions are yet in store for the human race.

Electrical Prospecting Not Magnetic

MODERN METHODS of electrical prospecting are quite different from practice with the well-known magnetic dip needle, though there seems to be misconception on the part of some of those who have not followed the subject closely. In the leading editorial in *The Wall Street Journal* of Oct. 15, for example, the writer pays a compliment to this advance in science, but in speaking of the orebodies located by the Lundberg method of prospecting, he says "Such orebodies are, of course, magnetic, and, what is more important, measurably magnetic." Of course they are not, at all, or certainly not measurably so. It is the conductivity of the orebodies that is the critical factor—the difference between the conductivity of ore and that of the barren rock.

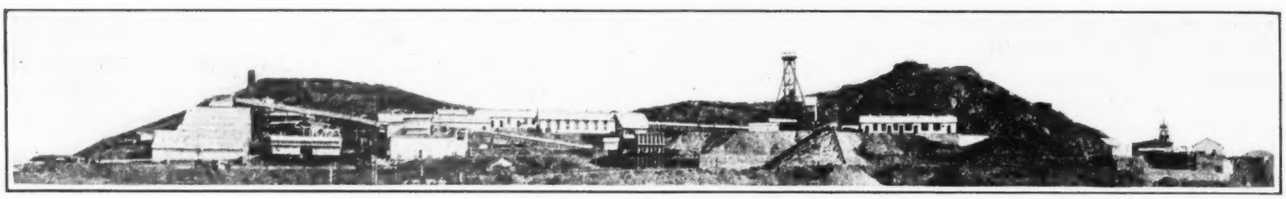
Incidentally, no good monograph on electrical prospecting methods has yet appeared, certainly not in English, and one is needed. Perhaps the U. S. Bureau of Mines could divert some of its resources to collecting information and making a study of the subject.

Selective Flotation at Parral

Low-Grade "Base" Ores Yield Profits in One-Time Bonanza Silver District

By Arthur Barrette Parsons
Assistant Editor

FLOTATION, particularly selective flotation, numbers among its achievements a revolution in mining operations in many places: one of these is Parral, the famous old silver-mining district in Chihuahua, Mexico. Twenty-five years ago the introduction of cyanidation at Parral wrought wonders in enabling the mine owners to exploit large bodies of low-grade ore that had been unprofitable during 270 years of high-grade mining. Although cyaniding is still practiced, as indicated in the accompanying table of current operations [in November, 1925], it is obvious that flotation is the important method of beneficiation. It is highly significant that a flotation unit is already being built in conjunction with the one plant—that of the Veta Grande Unit—in which cyanide treatment still survives. This is preparatory to handling the sulphide ores. Prior to the introduction of flotation in the district, "gravity" concentration was tried, with generally indifferent results so far as cheerful entries on ledger sheets were concerned.



Parral Unit of the American Smelting & Refining Co.

At the left is the new 500-ton flotation concentrator connected by an inclined conveyor to the crushing plant. Next are the office buildings and to the right La Prieta mine plant on Cerro de Santa Cruz. The photograph is taken from Parral Station.

La Prieta Is Newest Concentrator

Of the half dozen reduction plants now operating in the district, the newest is the 500-ton selective flotation concentrator of the Parral Unit of Cia. Minera Asarco. As might be deduced from an analysis of the word Asarco, this company is a subsidiary of the American Smelting & Refining Co. A little more than three years ago the Smelting company acquired a group of old mines on the Cerro de Santa Cruz, at the foot of which the City of Parral is situated. These included La Prieta, Tajo, Jesus Maria, and other properties. After a brief period of successful mine development, the erection of a flotation plant was begun. Construction was completed and operations were started in January, 1925.

The silver-lead ores always have been noted—possibly "notorious" is the word—for their zinc content. It is not surprising that large tonnages of silver-lead-zinc ore, ideal for selective flotation, are available, and that excellent results are being secured. Before describing the operations of this new plant, however, I shall outline briefly the situation in the district as I found it during a brief visit there last fall. Besides the Parral Unit, the A. S. & R. Co. has three other operations in the area of which the city of Parral is the center, and still another important producer is the San Francisco Mines of Mexico.

The Veta Grande unit is a consolidation, effected in 1919, of a number of properties, including the Veta Colorado, on which the present cyanide plant was built. Parral Consolidated has as a nucleus the old Alvarado property, the present flotation concentrator being the old Alvarado mill, remodeled and re-equipped. The flotation plants of the Santa Barbara unit were formerly the Tecolotes and San Diego concentrators. Introduction of selective flotation in one plant, and of a combination of tabling and flotation after sulphidizing carbonate minerals in the other, has accounted for the good results obtained here. Sodium sulphide is the reagent used for conditioning the carbonate mineral. At the San Francisco plant satisfactory results have been attained as a consequence of some alterations in the old concentrator and the adoption of selective flotation.

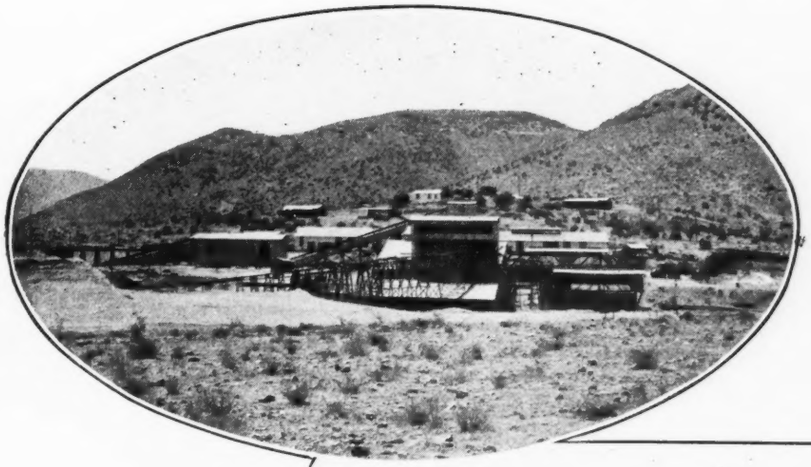
Dry and Sulphide Ores

The typical ore deposits of the district are fissure veins and fracture zones in andesitic and rhyolitic rocks. The vein material is highly siliceous. Much of the silver ore, particularly that mined years ago, can be characterized as "dry," in that it contains little lead; nor is there much zinc. In the upper levels of the mines silver chloride and iron oxide frequently are found; in the lower horizons, sulphides of silver, pyrite, galena, and zinc blende may be present in varying quantity. Veins or lodes, generally speaking, are wide. The fracture zone at the Veta Grande has a maximum width of

Status of Mining Activities at Parral Last November

Operation	Resident Manager or Superintendent	Ore Treated, Tons per Month	Plants	Product
Asarco-Veta Grande unit	H. H. Sharp	30,000	Cyanide	Bullion
Parral Consolidated—Managed by A. S. & R.	H. H. Sharp	12,000	Flotation	Silver-lead concentrate
Asarco-Santa Barbara unit	P. B. Lord	22,000*	Selective flotation	Silver-lead concentrate
		18,000†	Tables and sulphidizing flotation	Zinc concentrate
Asarco-Parral unit	S. E. Reed	15,000	Selective flotation	Silver-lead concentrate—zinc concentrate
San Francisco Mines of Mexico	E. Strout	15,000	Selective flotation	Silver-lead concentrate—zinc concentrate.
Totals		112,000		8,000 tons lead concentrate—5,000 tons zinc concentrate

*Sulphide. †Carbonate.

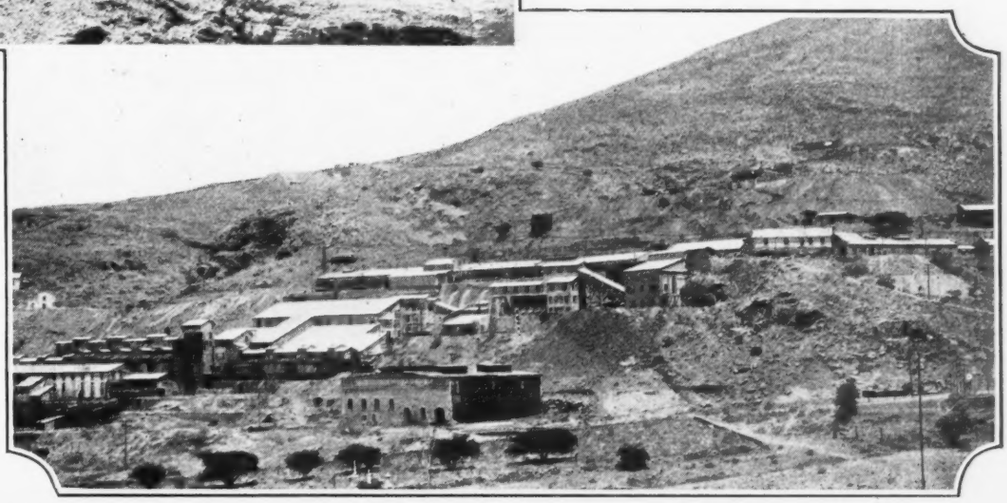


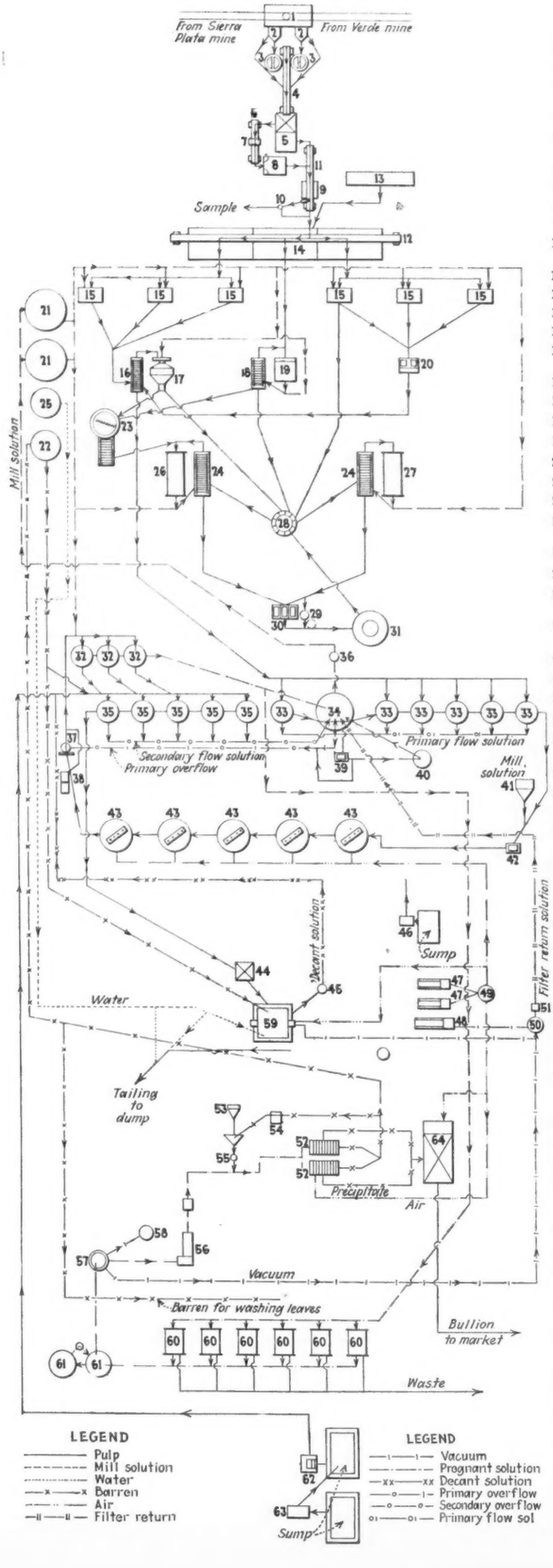
Four of the Six Reduction Plants in the Parral District. Flotation Is the Process in All But One

Above — The San Diego or "Carbonate" flotation plant of the Santa Barbara Unit of the A. S. & R. Co. Right—Plant of the San Francisco Mines of Mexico, also at Santa Barbara

Left—Tecolotes or "Sulphide" flotation plant of the Santa Barbara Unit. Ores sent to the San Diego plant are sulphidized before floating; here the sulphide is subjected to selective flotation

Right — The only surviving cyanide plant, at the Veta Grande Unit of the A. S. & R. Co. It treats a larger tonnage than any other in the district





Flow Sheet of Veta Grande Cyanide Plant

1. **Coarse crusher bin**; capacity, 200 tons.
2. **Two grizzlies**, 1 in. x ¾ in. x 3 in. deep bars, 2-in. opening.
3. **Two gyratories**: 1 Allis-Chalmers, Style 6K; 1 McCully No. 6, crushing to 3 to 4 in.
4. **Conveying belt**, 20 in. x 279 ft. long.
5. **Gates revolving screen trommel**, ¾-in. plate, round holes, 2¼ in., 4 ft. x 5 ft. diameter.
6. **Picking belt**, 36-in. wide, 128 ft. 6 in. long, 60 f.p.m.
7. **Magnet.**
8. **Symons disk crusher**, 48-in. horizontal.
9. **Merrick weightometer**, conveying type.
10. **Sampler**, Guanajuato automatic, 5 per cent cut; then 5 per cent cut through Dave Cole cutter.
11. **Conveyor belt**, 20 in. x 380 ft., 339 f.p.m.
12. **Mill bin conveyor belt**, 18 in. x 177 ft., 339 f.p.m.
13. **Lime bin**, 725-ton capacity.
14. **Ore bin**, 1,260-ton capacity.
15. **Sixty stamps**, 1,200 lb. each, 12 batteries, 110 drops per minute.
16. **Classifier**, Dorr type, speed 21.9 strokes per minute.
17. **Hardinge mill**, 8 ft. x 30 in. Uses 2½-in. steel balls, 28 r.p.m.
18. **Dorr duplex classifier**, 24 strokes per minute.
19. **Marcy mill**, No. 86; 22.6 r.p.m.
20. **Two battery elevators**, 20-in. belt, 395 f.p.m.
21. **Two mill-solution tanks**, 36 x 12 ft. and 36 x 10 ft.
22. **Barren-solution tank**, 20 ft. diameter, 18 ft. high.
23. **Bowl classifier**; 14-ft. diameter, 16 strokes per minute. Used when Hardinge is down.
24. **Ten Dorr classifiers**, duplex Model C, 13.2 strokes per minute.
25. **Water tank**, 28 x 10 ft.
26. **Five tube mills**, Chihuahua Industrial Co., 5 x 14 ft.; Danish pebbles; 26 r.p.m.
27. **Five tube mills**, Allis-Chalmers, 5 x 14 ft.; Danish pebbles; 26 r.p.m.
28. **Veta Grande distributor**, 10 segments, 20 r.p.m.
29. **Wilfley sand pump**, 6-in., used in place of elevators, 860 r.p.m.
30. **Three bucket elevators**, 20-in., 427 f.p.m.
31. **Two settling cones**, 8-ft. diameter.
32. **Three primary washing thickeners**; two 50 x 12 ft., one 50 x 10 ft.
33. **Six primary thickeners**, 6 minutes per revolution, 36 x 12 ft.
34. **Mill sump tank**, 36 x 12 ft.
35. **Five secondary thickeners**, 36 x 12 ft.
36. **Goulds triplex pump**, 12 x 12 in., mill-solution, 41 strokes per minuute.
37. **Wilfley sand pump**, 6-in., 1,200 r.p.m.
38. **Two air lifts**, 8-in., for pulp.
39. **Wilfley sand pump**, Model C, 4-in., 500 g.p.m.
40. **Two storage tanks**, 15 x 32 ft.
41. **Cyanide cone**, 6-ft. dia., for emulsifying with solution; air agitation.
42. **Three bucket elevators**, 20-in.; to agitators.
43. **Five agitators, Dorr type**, 25 x 25 ft., 2.3 r.p.m.
44. **Two distribution boxes** to Oliver filters.
45. **Decant solution pump**, 3-in. Wilfley, capacity 300 g.p.m.
46. **Wilfley sand pump**, 6 in., from catch-all sump.
47. **Two air compressors**: one, Ingersoll-Rand, 16 x 14 in. stroke, Imperial type X-B, 176 r.p.m.; one, Class 10, 16 x 14 in. stroke, 171 r.p.m.
48. **Vacuum pump**, 27 x 14 in., 177 r.p.m.
49. **Four air receivers.**
50. **Two vacuum receivers.**
51. **Two filter return pumps**: one 4-in. Byron Jackson, 500 g.p.m.; one 4-in. Goulds centrifugal, double-suction, single-stage, 500 g.p.m.
52. **Two Merrill precipitating presses**, 52-in. frame, 35 leaves.
53. **Merrill zinc feeder.**
54. **Two Worthington pumps**, 4-in., pumping emulsified zinc to pregnant solution.
55. **Fairbanks, Morse centrifugal pump**, 1½-in., barren solution to zinc cone.
56. **Three triplex pumps**: one 10 x 10 in. Worthington, 350 g.p.m., two 6 x 9-in. Aldrich, 150 g.p.m.
57. **Crowe vacuum tank**, 6 x 12 ft.
58. **Gardner-Rix vacuum pump**, 6 x 4½ in.
59. **Ten Oliver filters**: **nine**, 12 x 16 ft., 5½ min. per revolution; one, 12 x 12-ft., 5½ min. per revolution.
60. **Six Kelley pressure filters.**
61. **Two pregnant solution tanks**, 20 x 10 ft.
62. **Wilfley sand pump**, 500 g.p.m.; Model C.
63. **Goulds pump**, 8 x 12-in. triplex.
64. **Reverberatory furnace**, 12 x 4 x 2 ft. oil-burning.

200 ft. between walls; the vein at the Prieta averages more than 30 ft. in width and dips 55 deg. First operations, incidentally, at Santa Barbara were in 1556, whereas the earliest work in the immediate vicinity of Parral was done, according to probably authentic records, in 1632. Estimated production is $500,000,000, a "round" figure that will serve as well as any.

Use Stamps and Marcy Ball Mill

During a very brief stay in the district I had opportunity to visit only the Parral and Veta Grande operations of the Asarco company. At Veta Grande the mill feed is a mixture of old fill and virgin ore averaging about 12½ oz. silver per ton, with almost no gold. The plant was originally erected under the direction of Bernard MacDonald in 1910 and 1911. Incidentally, it is the birthplace of the Parral agitating tank, and likewise the last resting place of the device, now extinct so far as can be ascertained.

The treatment is that characterized as all-sliming. Initial grinding is done in a battery of sixty stamps and a Marcy ball mill; the second stage is accomplished in ten 5 by 14-ft. tube mills and one Hardinge mill. After preliminary thickening, the pulp is agitated in tanks of a modified Dorr type, arranged in series. Wash water is added and the pulp is passed through a second series of thickeners, before being filtered on ten Oliver machines. Each filter is scrubbed daily, and acid is used on alternate days. This procedure has been found to keep the machines up to capacity for a maximum length of time and also to assure a satisfactory wash. The Kelley pressure filters, originally installed to handle the pulp, are now used as clarifiers for the pregnant solution. One press is cleaned each day. Precipitation is effected by the Merrill-Crowe procedure. The accompanying flow sheet shows the course of the ore and solutions through the plant and gives many details of the equipment.

The following table, giving the material of which sundry wearing parts are made, shows the choices made as a result of comparative performance and costs records.

Part	Material
Gyratory concaves	Manganese steel
Gyratory wearing plates	Manganese steel
Symons crusher, disk	Manganese steel
Marcy breast liners	Manganese steel
Stamp battery, shoes and dies	Chrome steel
Hardinge liners	Local cast iron
Tube-mill liners (El Oro)	Local cast iron
Hardinge balls	Chrome steel
Marcy balls	Chrome steel
Tube-mill pebbles	Danish flint

Each of the motors driving the ball and tube mills is supplied with power through an individual ammeter; a reading on the ammeter below an established normal indicates an overloading of the tube with pulp and consequent inefficient grinding. At periodical intervals each mill is cut out of the circuit to permit a check up of the ball load. The delay is more than compensated for by increased grinding efficiency. The Marcy, running at 22.6 r.p.m., does the best work when the pulp contains 28 per cent moisture; the Hardinge with a finer feed and a speed of 28 r.p.m. is most effective when the moisture is 24 per cent.

Aero brand 49½ per cent sodium cyanide is used, the strength of the solution ranging from 2 lb. per ton in the first agitators down to 1.5 lb., with a protective alkalinity of 1 lb. per ton in terms of calcium oxide. Pulp consistency in the agitators is maintained at 1.2 parts of solution to 1 part solid. The silver content of various solutions is about as follows: agitators, 250 gm.; primary thickeners, 100 gm.; secondary thickeners, 55 gm. The tailing loss of soluble silver is 2 gm. per ton.

Zinc dust, emulsified with barren solution, is fed into the pregnant solution line only a few feet from the intake of the Merrill precipitating presses. The object is to permit the accumulation of a layer of zinc instead of very fine precipitate on the canvas of the press through which the solution will filter. This lessens the clogging of the cloths and at the same time effects good precipitation.

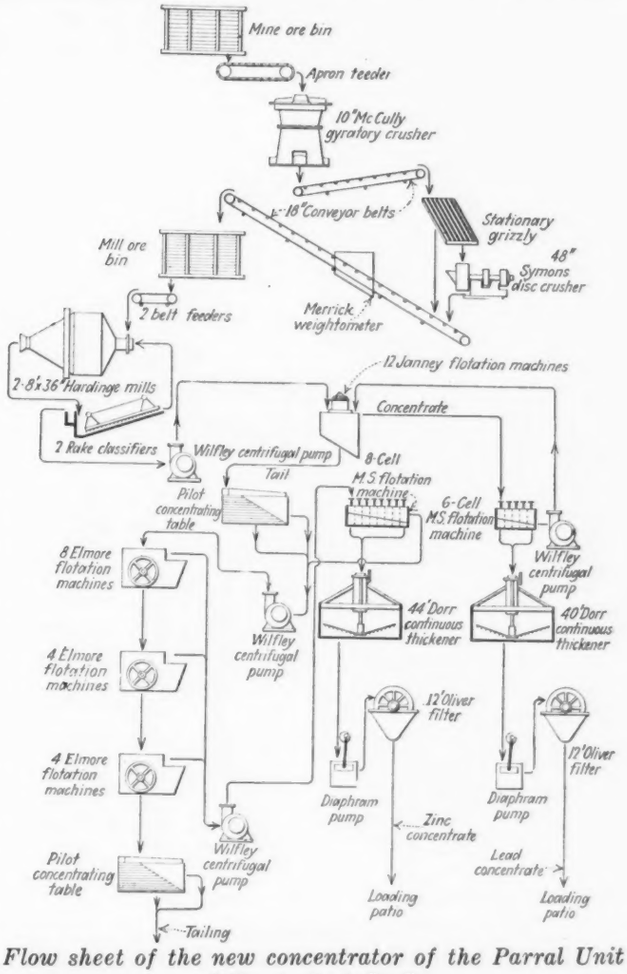
A range of typical analyses of the precipitate shows:

Metal	Per Cent
Silver	60 to 70
Lead	10 to 17
Zinc	1.5 to 2.5
Copper	2 to 4

Bullion, 850 fine, is produced by melting with crude-oil flame in a small reverberatory furnace with sand and soda as fluxes. I am indebted to Mr. Sharp and H. S. Wildman, metallurgist for the Veta Grande unit, for the data that have been given; and to H. A. Guess, vice-president of the A. S. & R. Co., in charge of mining operations, for permission to publish these and the flow sheets.

New Selective Flotation Plant

Quite different from the other ore-treating plants in the district is the new 500-ton concentrator of the Parral unit. It emphasizes the rapid evolution in the methods of mill construction: smaller floor space for a given tonnage, yet an absence of crowding of the equipment; a better mill building; and improved equipment,



Flow sheet of the new concentrator of the Parral Unit of the A. S. & R. Co.

not alone in the major items of machinery but in what may be called accessories, such as feeders, conveyors, pumps, and devices for power transmission. Such things are characteristic of present-day construction in general and of the Parral plant in particular. For example, large skylights of corrugated, wire-reinforced glass provide excellent light; upper floors are made of subway grating; traveling apron feeders afford positive and uniform flow through the plant; and Wilfley sand pumps elevate various pulps efficiently and without interruption. Timkin roller bearings are provided for Robins conveyor belt idlers; and Skayef ball bearings for the Elmore flotation machines are measures for saving power.

Three Kinds of Flotation Machines

There is little about the flow sheet, as shown in the accompanying illustration, that requires explanation. Janney flotation machines (combined agitation and pneumatic) make a rough lead concentrate that is cleaned in Minerals Separation cell; whereas three sets of Elmore machines in series make a zinc concentrate to be cleaned in M. S. machines. The Elmore depends on mechanical agitation alone for its results; it is of the horizontal drum rotor type.

The arrangement of the Elmore machines in the zinc circuit whereby the tailing from each of the first two sets is re-treated illustrates the flexibility of flotation flow sheets and the wide variety of ways in which the machines may be combined. The use of three distinct types of machines shows the same thing.

Reagents for the lead cells include thio-carbanalid, sodium xanthate, and cresylic acid. Sodium cyanide is used to depress the zinc and iron, but zinc sulphate is not found necessary. For reviving the zinc in the tailing from the lead circuit, copper sulphate is used, and pine oil, creosote, and more xanthate are introduced. Grinding of the disk-crusher product, 95 per cent through a ½-in. ring, is accomplished in two Hardinge conical mills using chrome steel balls imported from the United States. The flotation feed averages about 55 per cent through 200 mesh. Air for the flotation cells is supplied by a horizontal low-pressure rotary Roots blower.

Concentrating Tables Serve as Barometers

As pilots to guide the operator in feeding reagents and otherwise controlling operations are three quarter-size Wilfley tables, one in the lead circuit and two in the zinc circuit. No separation is attempted but the tables serve an important function nevertheless.

The plant was designed originally to handle 400 tons per day, but this can easily be exceeded, 500 tons being hardly the maximum efficient capacity. The products are two: lead concentrate, assaying 60 per cent lead, 10 per cent zinc, and 1,500 gm. silver per ton, which is shipped to the A. S. & R. smelter at Chihuahua; and zinc concentrate, assaying 50 per cent zinc, 2 per cent lead, and 350 gm. silver. This goes to the A. S. & R. zinc-retort plant at Rosita, in Coahuila, where gas from the byproduct coke plant is used as fuel.

As marking the progress toward more efficient equipment in the Parral district, the replacement of the old mine pumps by centrifugals may be mentioned. At La Prieta (Parral Unit) 6,000 gal. of water per minute is being lifted 600 ft. by electrically operated pumps, including Layne-Bowler and other types of centrifugals. At the Verde mine (Veta Grande Unit) three Allis-Chalmers quintiplex centrifugal pumps, each with a capacity for lifting 500 gal. per minute against a head of 1,000 ft., recently have been installed, and further centrifugals are planned to replace the present plunger pumps. Provision is to be made for pumping a total of 3,500 gal. per minute.

Hydro-Electric Power Cut Costs

The district is supplied with hydro-electric power generated by the Mexican Northern Power Co. at La Boquilla, on the Conchos River, the site being only about 50 miles from Parral. This less costly power has been available for only a few years, and naturally it has been a factor in stimulating activity in the district.

It may be remarked, incidentally, that Swedish drill steel and German explosives give better returns, dollar for dollar, than do similar supplies from the United States. This is shown conclusively by the fact that American companies buy them in preference.

Parral is blessed with cheap hydro-electric power; with good transportation facilities, and a reasonably short haul to smelters; with ample capital for development and equipment; and with competent management. More important than all these of course is the matter of orebodies. Without having actual figures of ore reserves on which to base an estimate of the probable life of the mines, it seems safe to say that there are large lodes of profitable ore—assuming reasonably high metal prices. The outlook for the camp for the next decade is good.

Silver to Be a Metal of Lessening Importance?

Silver is losing its prestige, is the tenor of an article in *The Statist*, of London, in the Oct. 2 issue. Lack of resisting power has been the characteristic of the market for some weeks, says the writer, and more fundamental causes than mere speculative activity must be advanced to explain the steady downward trend in the value of silver, which has brought the spot quotations to the lowest level reached since the end of 1915. The two main fundamental factors are well known: expanding production and the dwindling utilization of the metal for currency purposes. In Europe silver will never occupy the position it once held as token currency. Nations have learned to be satisfied with cheaper tokens; even England has considerably debased the fineness of its silver coins. In the East one of the evidences of economic progress, as Western civilization appreciates it, is the transition from a metallic to a paper currency. In India this movement is to be greatly accelerated by the adoption of the Currency Commission's recommendations. Similar strides are being made in China, whence comes the report that the use of bank notes is growing and that their superiority over silver as medium of currency is gaining an ever-widening number of adherents in the interior of the country. The disfavor into which silver has been falling as a means of exchange may in time affect the estimation in which the metal is held as a store of value and as an ornament in the East.

The *Wall Street Journal* remarks that "Increase in production of silver with no corresponding increase in consumption would appear to be the crux of the present situation in the silver market." It says that any increase in consumption must be the result of expansion in one of its present uses, which are in number "more or less limited."

Notes on Ancient and Primitive Mining and Metallurgical Methods—III

Mines of the Athenians at Laurium—Character of Ore Deposits and Methods of Working—Concentrating and Smelting—The Romans in Spain—Lead Winning in Britain—Metallurgical Methods

By T. A. Rickard

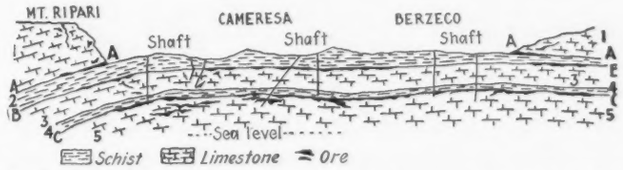
THE EXPLOITATION of silver-lead ore and the production of the component metals was an important industry in Attica at a remote period, the mines of Laurium having been worked long before the days of Xenophon, who wrote a report on them in about 365 B. C. From these mines the Athenians drew the wealth that enabled them to become the leaders of the Greek world, during the fifth century B. C.

Laurium is situated in the southern part of Attica near the promontory of Sunium. The center of the district is about 25 miles south of Athens. The mines were the property of the City-State which, however, did not operate them on its own account, but leased them to private individuals or groups of adventurers, who paid a premium, usually one talent (equivalent to $1,200 of our money) for the lease, and also a rent, or tribute, of one twenty-fourth (about 4 per cent) of the gross output in bullion. These leases were granted for terms of three to ten years, the longer period being allowed on ground that was unprospected. For this purpose the mining district was divided into tracts of suitable size. Sometimes a syndicate was formed for exploratory work, the ore-bearing ground being divided among the members of the group.

The ore occurs principally in a limestone, of Cretaceous age, near its contact with schist. These sedimentary rocks are intersected by dikes of granite and gabbro, which break and displace the beds of schist and limestone. A vertical section of the district (after Cordella) shows the following sequence of formations, as shown on the accompanying sketch:

1 Upper limestone	Partly eroded
A First contact	
2 Upper schist	180 to 480 ft. thick
B Second contact	
3 Middle limestone	190 to 250 ft. thick
4 Lower schist	210 to 450 ft. thick
C Third contact	
5 Lower limestone	450 to 900 ft. thick

The thicknesses of these formations vary locally. The first contact is at the base of the Upper limestone, where it lies on the mica-schist; this ore-bearing horizon has been subjected to erosion, so that most of it is gone, but along the portions that remain are the places in which the earliest mining was done, because there the ore appeared at the surface. The cuts or passages in the hillside were the *laurai*, or lanes, that gave Laurium its name. In the schist underneath the topmost limestone were found veins of ore that continued downward and led the ancient miners to dig more deeply into the formation, until they reached the second contact, above the Middle limestone, where they found more ore, but of relatively small thickness. Later, having noted the fact that the ore followed the contacts and in places extended irregularly below them for considerable distances, the Greeks persevered in their deeper exploration until they penetrated the third contact, on top of the Lower limestone. Along these contacts, more especially the third, the ore had the form of tabular



Geologic section of formations at Laurium, showing the shafts put down. See text for explanation of letters and numbers used

masses, as much as 35 ft. thick, whereas in the schist it filled fissures of irregular shape.

Large Stopes at Cameresa

The principal ancient workings on the third contact are at Cameresa; there are the big stopes that the miners of the classic period excavated in the Lower limestone. Some of the ancient stopes must have yielded fully 100,000 tons; and near them the largest orebodies have been found by the French company that reopened these mines in 1864. Huet, writing in 1879, says: "In this third contact the minerals of lead in all their forms are found abundantly and are rich in silver, their tenor being rarely less than two kilogrammes (64 oz.) per ton of lead." The ore mined by the Athenians was chiefly galena, which contained the silver in a proportion that ranged from 30 to 300 oz. per ton. With the galena were associated both pyrite and blende, in small amounts. During modern days, however, the mines of Laurium have been exploited by various French companies, chiefly for the zinc, which is more plentiful in the deeper workings.

The ancients sank more than 2,000 shafts, one of which is 386 ft. deep; but none of the workings extended below sea level[1]. The main shafts were 4 ft. by 6 ft. in section. It is estimated that the rate of sinking was about 15 ft. per month. Some of the shafts were inclined so as to serve as stairways, the steps of which are still to be seen. The underground passages were only from two to three feet in height and width—just large enough to admit the miner, but much too small for effective work. The largest masses of ore were removed by digging downward, this underhand stoping being facilitated by inclined drifts, up or down, as required to connect with the nearest level. Some of the stoping, however, was done in better fashion, upward or overhand, followed by filling underfoot. The system of stoping generally was of the pillar-and-stall type. In

[1] "Les Mines du Laurion dans l'Antiquité," by Edouard Ardaillon, 1897.

big openings the Athenians left pillars, usually in poor ore, to support the roof; in the days of Lycurgus, about 330 B. C., a law was passed to punish anyone removing these supports. We read that Diphilus, who had enriched himself by removing the ore of the pillars left to support the old stopes, was condemned to death. The fortune of the culprit, amounting to 160 talents, was distributed among the citizens. In the smaller stopes the roof was restrained by walls of dry stone; timber was used also, but sparingly. The workings of Laurium are in what the miner would call "good ground," not difficult to break and yet not prone to collapse. The present state of the workings proves how favorable in this respect were the conditions under which the Athenians conducted their exploitation.

Ventilation a Problem

The workings were dry, but they must have been poorly ventilated, because the passages were small and crooked. The main drifts were run in duplicate, parallel to each other, and connected by short crosscuts, to promote the circulation of air. This was stimulated also by the multiplicity of the entries, which were closed as required, for the control of the ventilation. The primitive method (known as fire-setting) of assisting the breaking of the rock by means of a wood fire at the face must have been impracticable in these mines, on account of the difficulty of expelling the fume resulting therefrom; but fires were used to expedite the movement of air in the shafts, each of which, moreover, was divided by a tight partition, so that one compartment could be projected above the other at the surface, and thereby establish a draft.

The work was done by slaves, each of whom was provided with a lamp, made of terra cotta, or baked clay, having a capacity for enough oil to burn ten hours, which therefore was the length of the shift. Niches in the rock show the places where the lamps rested while the slave, in his cramped quarters, pecked at the rock. He dug about twenty-five tons per month. His tools consisted of a hammer (weighing six pounds), a moil, a pick, and a shovel, the metallic parts of which were made of hammered iron that had been tempered by quenching in water. Most of the slaves, but probably not all of them, were fettered; they were branded with their owner's name; and they toiled under conditions obviously so irksome and insanitary as to be abhorrent to a modern engineer. Xenophon quotes Socrates as saying of the silver mines: "They say the place is very unhealthy." This was a philosophic way of stating the case. The supervision was slight, because the amount of work the slave had to perform could be measured easily at sight, even by a relatively incompetent man. Xenophon records the fact that Nicias bought a skilled overseer for a talent of silver, which high price indicates that not many were engaged. The superintendents, or *epistatai,* were slaves.

Broken Material Removed in Bags and Baskets

The broken ore and waste were removed in bags made of hide and panniers made of esparto grass. The ore-carriers were called *thulakophoroi,* the sack being a *thulakos;* they resembled the Mexican *zurroneros* and *tanateros,* so named from the bag, made of rawhide, called a *zurron,* and the sack, made of fibre, called a *tanate.* The load, 150 to 200 lb., carried on the back, is attached by a cord to a strap across the forehead. In like manner the slave of antiquity carried the ore out of the mine, and so does primitive man still continue to perform his porterage. Recently in East Africa I saw the Kikuyus holding their loads in position by a strap passing around the forehead. Some of the ore in the mines of Laurium was brought to the surface in this way on the backs of slaves, but much of it was hoisted by aid of a windlass.

An Ancient Crushing Plant

A little sorting was done underground; and when the ore reached the surface it was broken smaller, previous to further sorting, the waste being rejected, while the valuable mineral was separated into the portion that was rich enough to be smelted and the remainder that had to be concentrated on the washing-floors. In 1869 the old dumps were estimated at 7,000,000 tons, and since then as much more rejected material has been uncovered. The average lead content of this discard is from 8 to 10 per cent; only rarely does it exceed 12 per cent, which appears to have been the economic limit of the ancients.

Ardaillon gives the grade of the ore mined by the Athenians as 40 to 120 oz. of silver per ton of lead. The picked ore was crushed in stone mortars with iron pestles, and also in mills such as were used for grinding corn, operated by from four to six slaves. By these methods the mineral was reduced to the size of millet grain before being taken to the washing plant, which consisted of sloping tables, constructed of masonry, faced with mortar. These were about 70 ft. long, and were provided with small pockets at intervals to hold the water; the tables were placed at an angle, the head of one being near the foot of another, so that the water could be returned readily for re-use. The remains of some of these tables survive to this day. No running stream being available in this arid district, the Athenians built cisterns in which they caught the rainwater. Some of the smaller ones were cut in the natural rock, but most of the cisterns were made of masonry, wholly or in part. In a few gullies the water was impounded by simple dams. All these reservoirs were covered with plank, to check evaporation. Their capacity ranged from 160 to 580 cubic meters.

The Concentrates Smelted

Before the washing was begun, the crushed ore was sized by means of a rudimentary sieve, made partly of stone, suspended, so as to oscillate. The fine particles fell on the washing table, where the flow of water removed the lighter and worthless portion of the ore, leaving the heavy and valuable mineral, or concentrate, which was then collected in panniers and removed for further treatment by fire. A similar process was used in Spain, as Strabo tells us. He says that after the silver ore had been crushed it was sifted through sieves over water; the residue then was crushed afresh and sifted again; after five successive crushings and siftings, followed each time by the washing of the fine stuff, the residue on the table was taken to the furnace to be smelted.

At Laurium the concentrate was added to the rich ore, and from the smelting of this mixture was produced the work-lead, the *stannum* of Pliny, or lead containing the silver. How this was done we can only surmise, for the evidence is incomplete. Cordella, a Greek engineer, in 1869 found[2] the remains of some furnaces, from which it is inferred that the smelting was done in small

[2] "Le Laurium," by A. Cordella, 1869.

round vertical furnaces, or cupolas, 3 ft. in diameter, into which a blast was forced by a goat-skin bellows. The slag contained 5 to 14 per cent of lead. The work-lead, which averaged 130 oz. of silver per ton, was refined by cupellation, as is indicated by surviving masses of desilverized litharge and by the finding of cupels of baked earth in which the lead was assayed. It is assumed that similar cupels, on a larger scale, were used for the refining of the bullion.

The litharge was reduced by smelting with charcoal. Byproducts included iron ocher (which the Greeks called "cinnabar") and minium (the red oxide of lead), both of these being used as pigments. Sundry medicaments also were saved, such as zinc oxide and lead sulphate. Each pig of lead weighed 15 kg., or 33 lb. During the fourth century B. C. the lead sold for 5 drachmas per talent, or 1.14c. per pound, which indicates that it was plentiful. In the construction of heavy masonry the Athenians, instead of laying the stones in mortar, fastened them with clamps and dowels of iron laid in grooves and sealed with molten lead. In later days the Christians wrecked many classic buildings in search of the lead for making bullets to fight the Turks. Cordella estimated that in three centuries, from the sixth to the third B. C., the mines of Laurium yielded 2,100,000 tons of argentiferous lead, worth 4,171,378,600 drachmas, or about $800,000,000. More significant is the fact that when Greece was threatened by Persian invasion, under Xerxes, at the beginning of the fifth century B. C., the Athenians accepted the advice of Themistocles to build ships of war with the silver that had accumulated in the public treasury. With those ships the Greeks defeated the Persians on Sept. 20, 480 B. C., and turned the tide of history.

Pliny on Lead

Pliny distinquished lead from tin by naming one *plumbum nigrum*, or black lead, and the other *plumbum candidum*, or white lead. Lead was produced by his countrymen, the Romans, chiefly in Spain and Britain. Fifty-two small furnaces for smelting lead were found at Gata, near Almeria. Sixty ingots also have been unearthed in different parts of southern Spain, many of them near Orihuela. The reason for the decline in the Spanish lead-mining industry in Pliny's time is mentioned by him; writing in about 70 A. D. he says: "Lead is extracted with great labor in Spain and throughout the Gallic provinces, but in Britain it is found in the upper stratum of the earth in such abundance that a law has been passed prohibiting any one from working more than a fixed quantity of it." Evidently the lead was obtained from shallow workings in Britain, whereas in Spain the outcrops had been exhausted and the Romans in Pliny's day had been compelled to mine underground, making those miserable little gopher holes to which the word *cuniculus* (the Latin word for a rabbit) was applied appropriately, for their mines were like rabbit warrens.

Old Ingots Found in Great Britain

The natives of Britain worked the lead ore before the Romans, who, in turn, continued to operate the mines until the fourth century, in the reign of Constantine. As many as fifty-eight ingots of lead have been found in different parts of England and Wales; these are inscribed with the names of the successive emperors and even of the mining districts, so that a fairly complete history of the industry can be reconstructed, reaching from the reign of Claudius to that of Antoninus and Verus; that is, from 44 to 169 A.D. Then, after a pause, a resumption of mining ensued, to cease, as has been stated, in the days of Constantine, in about 320 A.D. The ingots have the shape of a truncated parallelepiped; they are usually 22 in. long and 5½ in. wide on the bottom, 19 in. long and 3¾ in. wide on the top, and 4½ in. thick. The usual weight is 176 lb. The lead was cast in molds of clay, the bottom of which was impressed, by means of a wooden stamp, with the lettering that the ingot was to bear on its upper surface. On one of them the marks of the molder's fingers have been reproduced, from the clay, upon the lead. These ingots, we may assume, were either lost or mislaid; some of them evidently were meant to be stolen, because they are found in curious positions, for examples, with heavy stones on top of them, the ingot laid face down, as if hidden with fraudulent intent. Others appear to have been laid aside to lighten the burden of a tired horse. Phillips, writing in 1859, says[3]: "Just as today the countryman whose galloway (small horse) is tired and drops the leaden load by the wayside for another day, so in the days of Rome the Brigantian lead was thrown down from the tired caballus (horse) by the side of the ancient mining road in Matlock Manor in Derbyshire and Dacre pasture in Yorkshire." Two ingots were found in the manor of Dacre in 1734; they were inscribed thus:

IMP. CAES. DOMITIANO AVG. COS. VII

This when expanded reads as follows: *Imperatore Caesare Domitiano Augusto Consule VII*, which means that the lead was produced in the seventh consulship of the emperor Domitian. This fixes the date as 81 A.D. On the side of one ingot is inscribed BRIG., which is interpreted Brigantium, meaning that the lead came from the district or mines of the Brigantes, the tribe that dominated Northumbria. In the hills of Derbyshire, between Wirksworth and Castleton, an important centre of lead mining existed during the Roman régime in Britain. The slag heap and excavations of the Romans are now confused with those made in the medieval period and in modern days, for here also the lead-mining industry was long-lived. Brooches and coins of the third and fourth centuries testify to Roman exploitation at a comparatively late date. Four ingots have been found on the moor near Metlock, where the Romans had both a mine and a smelter. In 1777 on Cromford Moor, near Wirksworth, an ingot was found inscribed thus:

IMP. CAES. HADRIANI AVG. MET. LVT.

This is expanded into *Imperatoris Caesaris Hadriani Augusti metalli Lutudarensis*, signifying that this lead from the mine of Lutudarum belongs to the emperor Hadrian, who reigned from 117 to 138 A.D. Lutudarum was somewhere between Chester (known to the Romans as Deva) and Leicester (Ratae).

Production of Lead Ordered Curtailed

According to the statement of Pliny, already quoted, the Romans were so successful in finding ample supplies of lead ore in Britain that at one time, in the reign of Vespasian, the production of the metal was excessive, and it had to be checked by law. This prohibition must refer, not to the operations under imperial officials, for

[3] "Thoughts on Ancient Metallurgy and Mining," "Archaeological Journal," 1859.

whom a simple order would have sufficed, but to those of the lessees, or *conductores*, of the mines. Such an inference is confirmed by the fact that several ingots have been recovered upon which honorific titles are absent. One, found near Wirksworth, in 1894, is beautifully inscribed:

P. RUBRI ABASCANT. METALLI LUTUDARES.

This indates that the lead belonged to Publius Rubrius Abascantus and that it came from the mine at Lutudarum. "Lutudares" is an abbreviation of *Lutudarensis*. Two ingots, one found in Yorkshire and one in Nottinghamshire, are marked:

C. IVL. PROTI. BRIT. LVT. EX. ARG.

which means that it belonged to Caius Julius Protius and is the product of the British mine at Lutudarum; also that the silver has been extracted from the lead. Nine ingots belonging apparently to private mine operators appear to have been produced in the Derbyshire district. The mines generally were the property of the state, and were operated in the name of successive emperors, but the lead mines of Latudarum in Derbyshire seem to have been worked by lessees or owners. A controversy has arisen in regard to the period at which these particular ingots belong. Unlike the imperial bullion, they give no clew as to their date. I shall not go into the details of the controversy; it suffices to say that the preponderance of evidence favors the conclusion that these ingots belong to the period of lavish production mentioned by Pliny.

Rudimentary Furnaces Used

The furnaces used by the Romans to smelt this lead must have been of a rudimentary kind, requiring little, if any, brick or stone. Probably the metallurgic hearth consisted simply of a flatly conical hole in the ground lined with clay.

The galena, previously roasted in heaps or in kilns, was placed on this hearth in layers alternating with charcoal, and when the fuel was well ignited a blast of air was blown into the charge by a bellows through a tube, or tuyère, of clay that rested on the edge of the hearth. A hood of wattle plastered with clay may have served to collect the fume and divert it from these engaged in the operation. The furnace, such as it was, had no tap hole; the molten metal must have been allowed to collect at the bottom of the hearth before being ladled into molds. At a later period, probably, the edges of the hearth were provided with a stone wall, such as was built around the furnaces at Laurium, and in due course a hearth may have been hollowed in a mass of cinders and clay, such as the Japanese made at one time, within stone walls, until the furnace stood, for the most part, above the level of the ground. Even such a furnace, however, would not have a tap hole, because it was too weak to withstand the rough treatment incidental to the forceful opening of an exit for the molten metal.

Smelting on Small Scale

Only a small quantity of lead was produced at any one time; this inference is made on the evidence of the ingots, the laminated structure of which indicates that the metal had been poured into the mold successively in thin layers with sufficient interval between each casting to permit one layer to solidify before the next one was poured over it. Most of the blocks of lead exhibit distinct lamination; one of them, found at Matlock, in Derbyshire, shows no less than thirty layers, as if made by accretion from the reduction at intervals of as many successive charges of ore. This observation need not prove the scarcity of the ore, but merely the small scale of the smelting operations. The purity of the lead, as regards its copper and antimony contents, is explained partly by the moderate temperature developed in such a rough smelting operation[1] and partly by the large proportion of lead that was allowed to pass into the slag.

Several of the ingots bear the mark EX. ARG. This has been variously interpreted, some archaeologists thinking that it is an abbreviation of *ex argentariis fondinis*, from the silver mines, or possibly *ex argento*, which would mean "made out of silver." Neither of these interpretations will fit the known facts, for the mines of Britain produced no notable amount of silver—they were lead mines essentially; moreover, the lead bullion has been desilverized, as was proved by Gowland, who assayed fifty-one of these British-Roman ingots and found that their silver contents ranged from 14 dwt. to 2½ oz. per ton of lead. This represents a fairly effective desilverization as compared even with modern practice. One ingot contains as much as 8 oz. 6.6 dwt. of silver per ton of lead; this is one of the earliest *massae plumbeae*, and it may be an ingot that had not been desilverized, in which event its composition is in accord with the supposition that the British lead ores were comparatively poor in the precious metal. In at least two instances the EX is followed by a period, indicating an abbreviation, so I venture to suggest that EX. ARG. stands for exempto argento, excreto argento, or some similar phrase in the form of an ablative absolute.

How Was Lead Desilverized?

Next comes the question, how was the lead desilverized? Light is thrown on this question by the discovery at Silchester, in Hampshire, of small fragments of Roman metallurgical hearths. An analysis of these fragments shows the presence of 7½ per cent of phosphoric acid, as lime phosphate, thus indicating that the Romans used hearths made of bone ash, as is customary today in the process of cupellation. Moreover, Gowland concluded that at Silchester the Romans, in refining their silver from bullion that contained both copper and lead, used special furnaces in which the bullion was cupelled with lead sufficient to remove the impurities. Such furnaces would be like those he saw in use among the primitive Japanese. A rectangular hole, 2½ ft. square, and about 15 in. deep, is dug in the ground. Into this is fitted a wooden box, open at the top. More rarely the hole, or hearth, is lined only with slabs of stone. The lower half of the box is filled with dry clay, while the upper half is stuffed with charcoal ash that has been well washed, so as to remove all the soluble alkaline matter. The contents of the box are then beaten down until a solid level mass remains in place. Next a shallow dish-like cavity, 12 in. in diameter and 2 in. deep, is scraped in the middle, and then carefully smoothed. This is now the hearth of the furnace. A clay wall is then built around it at a distance of 5 or 6 in. from the periphery, an opening 8 in. wide being left in front. The wall consists of slabs of clay, set vertically, about 7 in. high. The roof of this furnace consists of several clay slabs, or flat bricks, which rest upon the upper edges

[1] William Gowland: "The Early Smelting of Silver and Lead," "Archaeologia," Vol. LVII, 2.

of those that surround the hearth. A clay tube is inserted between two of the vertical slabs so as to admit the air from a bellows. Each furnace is surmounted by a hood of wattle daubed with clay, a hole being left for the escape of the fume. The Roman furnace must have resembled this except for the use of bone ash in lieu of wood ash. The shallow hearth was filled with charcoal, and when this was burning freely the silver was placed upon it, together with a determined proportion of lead. More charcoal was added, in a pile above the metal, before the bellows was started. When the metals had melted, and the furnace had attained the required heat, the fire was pulled away and heaped around the edge of the bath of metal that now filled the dish-like hearth. As the operation continued, the heat and the blast being jointly maintained, the lead was oxidized to litharge, into which the copper and other oxidized impurities were dissolved, to be absorbed together by the porous substance of the hearth. It is probable that the product from such a furnace as was used at Silchester was not pure silver, because not enough lead could be used; therefore the alloy of copper and silver was refined in another similar furnace, in which the refining was completed. Note may be made here that underneath the Roman slags found in Spain, which have been identified by the coins found in them, are the earlier slags made by their Iberian predecessors, of whom Strabo and Diodorus wrote. Such slags, even though apparently derived from the treatment of copper ores, contain lead, as if to suggest the use of lead for collecting the silver in the copper ore, by forming an alloy, followed by cupellation.

Roman Workings Largely Surficial

In regard to the mining methods of the Romans, as exemplified by the British lead mines, there is not much to say, because their workings were largely of a surficial character. On Shelve hill, in Shropshire, a series of ancient excavations has been found. Within an area 9 miles long and 5 miles wide the Romans dug into the outcrops of a number of nearly vertical lead veins by means of trenches and open cuts, which near the top of the hill appear to have been enlarged into what in these days we would call a glory hole, or large open pit. Several spades made of oak half an inch thick have been found in these workings; the spades have been hewn roughly, with some wedge-shaped tool, and they have a handle only long enough to be grasped by the hand. In the centre of each spade is a hole, beveled backward, so as to fit a staff or pole, the effect of which would be to convert the spade into a hoe.

In the mines of Flintshire, in North Wales, the Romans obtained much lead, especially near Halkyn. Iron picks, large and clumsy, suggesting the *fractaria* used by the Romans in Spain, have been unearthed there. The openings appear to have been in the form of trenches. It is likely that in their search for outcrops that could be mined easily the Romans used water under pressure, like the method still in vogue in Shropshire. This is called "hushing"; it consists in damming a stream of water and then releasing it suddenly, so that it rushes down the hillside with a violence sufficient to cut through the soil and thereby expose any outcrop of ore that may lie underneath. Pliny, it will be remembered, describes some such method as used for finding gold, and our miners in the early days of California practiced a system not unlike it, which they called "booming."

The work of the mines was done by slaves, either prisoners of war, criminals, or other persons whom those in authority wished to put out of the way; these unfortunates were *damnati ad effodienda metalla*, or condemned to digging in the mines. According to Pliny, the slaves in the Spanish lead mines worked by the aid of torches, the burning of which determined the length of their labor so that "they never saw the light of day for many months together." This statement, taken out of its context, has been quoted by sundry archaeologists as evidence that the slave gangs remained under-ground for months on end, whereas, as the context shows, it means only that they stayed in the mine for about ten hours, so that, in winter, when the days were short, they went down before sunrise and came forth after sunset. Thirty years ago the miners in Colorado and California likewise were given three candles apiece, which they stuck in the leg of one of their boots; the candles would give them light for the duration of their shift of ten hours, and when the days were short they, too, would miss the sunshine for months on end, unless haply their shift was changed from the day to the night.

In Britain, as elsewhere in conquered territory, the first mining operations of the Romans were performed by means of the natives, for such was the usual fate of a defeated people. It is probable, however, that when the conquest of Britain was completed the work of the mines was done largely by voluntary labor, for the Roman rule was not harsh, except during Nero's reign. We are told that Hadrian protected the freedom of those who had been illegally sentenced to the mines; which suggests that by that time (117-138 A.D.) only the worst criminals or the captives taken in border warfare were engaged in such work.

Legionaries at the Mines

The initials of the Second and Twentieth legions appear on some British pigs of lead, from which fact it is inferred that the soldiers were employed at the mines. They were stationed at the mining centers, we may presume, to maintain order among the workers, and to guard the mines themselves, which not unusually were protected by means of walls or other fortifications. But that the reluctant hands of the legionaries were employed also in the ignominious work of mining cannot be doubted, on the testimony of Tacitus and Etrabo. The Roman historian in his "Annals" states that Curtius Rufus, a successful commander in the wars with the German tribes during the reign of Claudius, discovered sundry silver veins in the country of the Mattiaci, in what is now Nassau. The mine, however, proved "of small advantage and of no long continuance." Rufus employed the legionaries in this work, and "they suffered from the labor of making excavations and from toiling underground, which operations even in the open air are strenuous and fatiguing." The soldiers, disgusted with this non-military occupation, and noting, it is recorded, that "the same drudgeries were exacted from the legions in other provinces," wrote in protest to the Emperor—with results that are not stated. Apparently when the number of slaves did not suffice, a Roman general or governor would employ the soldiers, many of whom probably were recruited from the native population. Under Probus this system is said to have become well established. In Spain, when labor was scarce, the Romans offered land or immunity from taxes to those who would work in the mines; it became the custom to bind the population of the mining districts to

the soil, even when the natives were permitted to profit by their industry; they were forbidden to migrate from the vicinity of the mines in search of employment elsewhere. This was the beginning of villeinage, from which the miner did not extricate himself until a thousand years later.

ROMAN MINES UNSANITARY

The unhealthful character of the miner's occupation is recognized by the Roman writers, who use the epithet *pallidus* repeatedly to describe his complexion. Statius, writing in Domitian's day, says: *Pallidus fossor redit, erutoque Concolor auro.*

"Pale the miner returns from his work, almost as pale as the gold he extracts." The poet addressed his verses to a friend in Dalmatia, and a reference is intended probably to the fact that the gold of that region is combined with so much silver as to spoil its ruddy color. Lucan, in his "Pharsalia," mentions "the pale searcher for the Asturian gold," the *Asturii scrutator pallidus auri.* Likewise, Silius Italicus speaks of the avaricious Asturian as being *concolor auro,* or of the color of the gold that he mines. In consequence of the foul air of their ill-ventilated diggings, the miners lost the hue of health; moreover, we have good reason for believing that their peculiar pallor was due to the hookworm, a disease that is fixed by insanitation. It is common to men of their calling, and continues to be endemic among the miners in Spain, in Italy and in the Balkan countries.

One might suppose from the references to the Asturians that they were a people who found pleasure in digging for gold, whereas the truth is that they were slaves brought from other lands and compelled to spend their miserable lives in unrequited toil in the insanitary holes of the Spanish mines. Ovid refers to the unhappy lot of the miner of that day in a passage that is but little known:

Haec facit, ut vivat fossor quoque compede vinctus,
Liberaque a ferro crura futura putet.

The *haec* refers to hope. The *compes* seems to have been a short chain attached to the miner's feet, to prevent him from running away, but not such as to impede him in his work. So the passage may be translated: "Hope it is that makes the digger live though bound in shackles, and makes him think of the day when his limbs will be free from chains." Until he became a free man, the digging for ore continued to be a mere grubbing in the ground; when the miner became a free citizen the art of mining was born, and, in due course, he became more than an ordinary artisan; he became the pioneer of civilization.

A Gold-Antimony Mine in France

Precious Metal Also Associated with Arsenic—Veins Are Low-Grade but Ancient—Producers' Assays Decrease with Depth

By Henry Briggs
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Prof. Henry Briggs

COMPARATIVELY few know that France is a gold-mining country, and fewer still realize the exceptional interest of her auriferous deposits. Insignificant though the output may be when compared with that of one of the big producing regions such as the Transvaal or the United States (before the Great War it stood at about $2,000,000 per annum), France can claim to have yielded gold long before either of those countries appeared on the map. Gold has, indeed, been obtained from the old provinces of Maine, Anjou, and Poitou from early times, and, apparently, from deposits which would now be regarded as decidedly low-grade. As in parallel cases elsewhere, the fact that a vein was mined extensively by the ancients does not necessarily mean that it can be profitably worked today. The "old men" obtained a high extraction on free-milling ore, and by employing slaves, or labor for which very little was paid, they were able to operate on ore which is in most instances untouchable under present-day economic conditions. Their skill in prospecting and in searching out the richer shoots was almost uncanny; for the shallower parts, at any rate, the fact that they worked a deposit for a while, and then abandoned it, is usually evidence that what they left is of little or no value.

Many of the old workings in western France have been lost; shafts and open pits have been filled up; waste heaps scattered and covered with soil, and the countryside long since restored to agriculture. Some of these all-but-obliterated ancient mines have been rediscovered of recent years, principally by Bellanger[1], from old maps and from the clews provided by place-names. I found farms and lands in Anjou bearing names suggestive of mineral wealth, and through them was successful in several cases in determining the position of workings whose existence had long since been forgotten. Near St. Denis-les-Lucs, for example, Bellanger noticed that there was a number of farms, lying along an almost straight east-and-west line, and possessing names such as *la Laurière, l'Auriére des Landes,* and like designations. A search ended in the rediscovery of a group of quartz veins containing arsenical pyrite bearing 5 to 7 dwt. of gold to the ton. Throughout this region, gold is often associated with arsenic or antimony, and in the occurrence at La Lucette its close connection with stibnite is one of the most striking features.

Situated near Laval, in the Department of Mayenne, in the midst of a slightly contoured and richly agri-

[1] "Note sur quelques gites de Quartz aurifère de la Vendée et de l'Anjou", *Ann. des Mines,* 11th series, Vol. IV, 1913, p. 20.

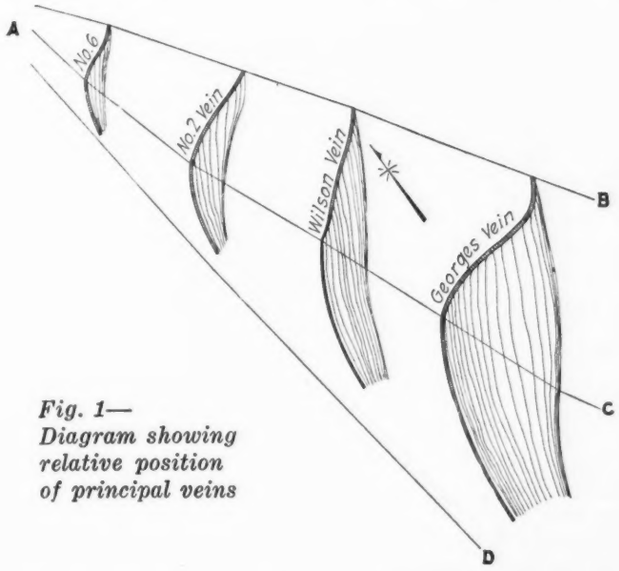


Fig. 1— Diagram showing relative position of principal veins

cultural district possessing none of the physical characteristics usually attributed to a metalliferous region, it is little wonder that the Lucette veins remained undiscovered until 1899. These deposits intersect rocks of the upper or Gothlandic division of the Silurian system. The strata actually encompassing the veins lie on a quartzitic sandstone floor, some 70 or 80 meters thick, which in turn rests uncomformably on rocks of the Upper Ordovician.[2] The hard sandstone floor, consisting of beds of differing color much cut up by strings of white quartz, is exposed to the west of the mine. On the horizon of the veins the country is a complex of compact, fine-grained sandstone and hardened silicified shales, the former predominating. Immediately above and below, soft shales cut off the veins so abruptly as to give significance to the expression "shale barrage," which is used at the mine in reference to them.

I have attempted to depict in the accompanying three-dimensional sketch, Fig. 1, the character of the peculiar little inlier in which the veins are found. The shape roughly resembles that of the prow of a boat, of which *ABC* (the surface) is the deck and *AD* the keel. The veins, of which four are shown, stretch athwart. This wedge-shaped piece of ground is bounded on the southwest side *(ACD)* by soft shale; though the junction is, I believe, regarded as conformable, the slickensided appearance of the rocks at and near it indicates some movement in that plane. On the opposite side *(ABD)* is a large fault coursing about northwest and southeast. The beds within the wedge dip at 35 deg., and the veins, which are almost vertical at the surface, gradually flatten out in depth, until, in the lowermost levels, their inclination practically corresponds with the dip of the strata. There are many other smaller faults in the wedge. They extend parallel to the boundary fault, and throw the veins they cross, though never seriously.

The small size of the mineralized zone will be gathered from the facts that the surface distance between the Georges vein and Vein No. 6 is 280 yd., the outcrop of the Georges vein is 165 yd. in length, and the greatest depth of the latter vein, measured along the dip, is about 350 yd. The whole of the Georges vein—the largest and richest of the group—lies within a belt of strata of about 220 yd. total thickness, measured across the stratification.

Though only four are indicated in the figure, there are actually nine veins, the majority being of no economic value; some, indeed, do not extend across the wedge but are situated in a limited width near the boundary fault, *AB*. The Georges vein was discovered about a year after stibnite had been found on the property and has been completely exhausted. At present, operations are confined to the Wilson vein, named in honor of the late President of the United States.

Gold-Bearing Quartz Used as Road Metal

The Georges vein was worked three years before the presence of gold was recognized, it being at first mined solely for stibnite, in which mineral the upper parts of the deposit were extremely rich. The quartz gangue was removed by hand-picking and by the ordinary processes of water concentration. At that time the only use made of the quartz was for road metal. The auriferous character of the quartz was discovered by the mine chemist, who assayed a sample and had the agreeable surprise of finding the precious button in his cupel, representing about an ounce of gold to the ton. Then followed a sharp crescendo of production, culminating in 1909 and 1910. In the latter year the antimony output touched its zenith at one-quarter of the world's total supply and brought in $320,000, and the gold yield realized its maximum of about $540,000. By 1911 development in depth had shown the Georges vein to narrow with increasing rapidity between the converging shale "barrage" on the south and the boundary fault on the north, and had proved the impoverishment of the lower portions both in stibnite and gold. Two years later that vein was worked out and the mine abandoned until, after the war, the Wilson vein was opened up. The Wilson vein may be described as a second edition of the Georges, presenting similar characteristics on a more subdued scale. In every feature—lateral extent, depth, thickness, productivity in stibnite, and grade of the auriferous quartz—it is inferior to its now-exhausted neighbor.

The most exhaustive mineralogical study of the

Fig. 2—Diagram showing relative position of axes of gold-bearing and antimony-bearing oreshoots

[2]E. Bellanger, "Le filon Georges des Mines de la Lucette," *Ann. des Mines*, 11th series, tome XII, 1921, p. 83.

Lucette veins is that written by Professor H. Douxami, of the University of Lille, the brother of the present mine superintendent, and the following account of the mineral content is taken from his memoir[3]: Stibnite and quartz are the chief but not the only minerals filling the fissures. The quartzose gangue frequently contains angular fragments of shales and micaceous sandstone broken from the walls. Calcite, either brought in in aqueous solution or produced from secondary reactions, is also found. In order of importance, mispickel, pyrite, and blende likewise occur, while a complete analysis of the vein-stuff indicates traces of platinum, nickel, cobalt, copper, and tin. Crystals of mispickel, examined under the microscope, often show free gold adhering to their surfaces. Generally speaking, the stibnite is not auriferous, and though the crude antimony is invariably so, Douxami considered its gold content to come entirely from the gangue (quartz, with mispickel and pyrite) still remaining with the dressed stibnite. The crude antimony contains about 5 dwt. of gold per ton.

It was some time after Douxami's study was written that the workings in the Georges vein penetrated into the zone of maximum enrichment in gold. As the mine deepened, the proportion of stibnite in the vein material diminished and that of quartz increased. The assay value of the latter also increased until it attained a maximum (or, rather, a series of maxima) in a belt of ground adjacent to the 165-meter level. Though the average value of the quartz throughout the whole period of mining the Georges vein was about 8 dwt. per ton, there were places in the enriched zone where the quartz assayed 6 oz. to the ton, and small specimens could be collected which were so rich in specks and spangles of visible gold as to constitute a temptation which the miners found difficult to resist. In spite of careful surveillance there was a good deal of theft. Beyond the zone of enrichment, and especially as the vein flattened out, the gold values, as well as the width of the deposit, rapidly fell off. In the more productive parts the Georges vein averaged about three yards in width; in the 306-meter level the width was 2 ft. 3 in., stibnite had disappeared, and the quartz assayed 8 dwt.; at the 320-meter level the width had decreased to 2 ft. 1 in. and the gold content to 2 dwt.; while at 340 meters the vein had become a mere string of quartz, 9 in. thick and assaying only 1.3 dwt. to the ton.

The carefully kept records enable it to be discerned that, on passing along any level in the Georges vein, the gold-assay value, or the productivity in stibnite, as the case may be, rose to a maximum and then decreased. By joining the maximal points in each level, lines, termed in Fig. 2 the axes of the shoots, are obtainable. (The dotted boundary line surrounds the productive ground, the figure having been developed on to a plane for ease of delineation). The interesting point then appears that the stibnite axis has no apparent connection with the gold axis, the former lying parallel to the boundary fault, whereas the latter is depressed to an angle of about 25 deg. with the strike of the deposit. The cross development of shoots of different ores in the same vein is new to me, and I should be interested to learn of any other similar instance.

The phenomenon is, I suppose, an indication that the stibnite and gold were deposited at different periods and under different conditions. No one, however, is qualified to write of the mode of formation of an ore deposit unless possessed of a particularly intimate and extensive knowledge of the deposit in question. In this case, I prefer to leave the matter to a more competent pen. But without stressing the fact it may be stated in passing that geodes, or large drusy cavities, are a common feature in both the Georges and Wilson veins; that their walls are often lined with well-developed crystals of quartz and stibnite on whose surfaces free gold has sometimes been deposited. Occasionally, the beautiful silvery lustre of the stibnite crystals is completely dimmed by the gold encrustation.

[3] *Ann. de la Soc. Geol. du Nord*, Vol. XXXVI, p. 83.

Gold Is Probably in Free State

The high extraction (about 80 per cent) of the gold by means of gravity stamps and direct amalgamation suggests that the gold occurs solely in the free state. Tailings from the stamp batteries are treated on tables of the Wilfley type, from which arsenical concentrates are obtained; these are sold to smelters in South Wales.

The presence of antimony minerals has long been known to be detrimental to amalgamation, the effect being to strip the mercury rapidly and completely from the plates. A former works manager at La Lucette solved that awkward problem by washing the plates with sulphurous water from the antimony works and scouring them with emery cloth, by which treatment it is claimed that the adhesion of the mercury to the plates is much improved.

Near the zenith of production, early in 1908, the mine and works engaged 600 persons; now there are 60 underground, 40 at the surface of the mine, and 100 in the antimony works.

The antimony works continue to flourish and to expand. The increasing use of metallic antimony in the arts and for storage batteries, and of certain of its compounds for face powders, is reflected in their size and activity. Any deficiency in the quantity of stibnite produced on the spot is more than made up by imports of the mineral from Morocco, Bolivia, and elsewhere.

This little industry, with its bimetallic output, helping with one hand to steady the tottering franc and with the other to satisfy the demand for cosmetics, ought, one would think, to be dear to the Gallic heart!

Greek Magnesite Production Increased Last Year

The mineral production of Greece in 1925, with the exception of zinc, lead compounds, magnesite, and lignite, followed the general decline characterizing Greek output during the last ten or twelve years, according to the U. S. Department of Commerce.

Production figures for the leading Greek minerals in 1925, as estimated by the Ministry of Agriculture, Commerce, and Industry, were as follows (in metric tons and with 1924 figures in parentheses): Lignite, 136,104 (111,000); magnesite, 90,828 (58,213); iron ore, 88,216 (96,000); salt, 77,714 (75,000); lead compounds, 76,716 (53,600); iron pyrites, 65,000 (76,051); calcined magnesite, 28,425. Nickel ore production, negligible since 1918, will be resumed in 1926 or 1927, according to a contract concluded in November, 1925, between the Government and a British firm.

Methods and Costs of Sinking American Eagles Shaft at Victor, Colo.

Size, 7 x 17 Ft., Sunk 600 Ft. at a Cost of $38.75 per Ft., Station Cutting Not Included—Time, Ten Months and Nine Days

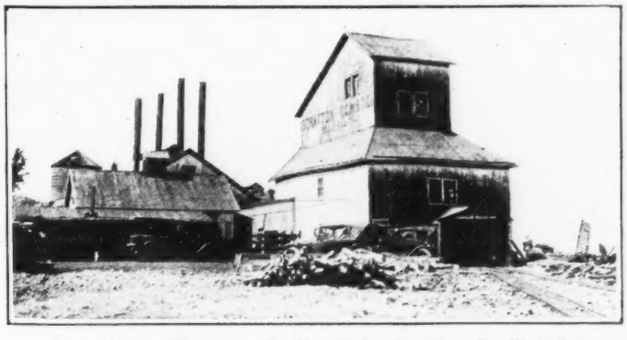
By A. F. Carper
Superintendent, Stratton Lease, Victor, Colo.

A. F. Carper

THE AMERICAN Eagles Shaft is near the center of the Bull Hill group of the Stratton Cripple Creek Mining & Development Co., at Victor, Colo., and is now being worked under an operating contract and option to purchase by the Stratton Lease. This group of claims, covering nearly two hundred acres, has had a total production in excess of five million dollars from the upper levels. The Portland, Cresson, Vindicator, and Golden Cycle mines adjoin the properties named, and have had a large production at much deeper levels than the deepest found in this group. As all of the upper levels have been under lease for more than twenty-two years, and as there is little possibility of large bodies being opened, it was decided to sink this shaft an additional 600 ft. and develop the known veins on lower levels. The shaft was sunk a total depth of 608.3 ft. from the 1,500 level to the 2,100 level.

The shaft sinking started April 1, 1924, and was completed Feb. 10, 1925. Total time consumed, including Sundays and holidays, was 316 days, or 632 shifts, as the sinking was done on a two-shift basis. During this time there were 304 shifts lost for the following causes: Frozen water lines, 10 shifts; station cutting and moving the sinking rig, 152 shifts; mine gas or bad air, 30 shifts; powder gas, 41 shifts; and change Sundays and holidays, 69 shifts. The average speed was 3.71 ft. per day.

The shaft was broken 7x17 ft. in the clear. After timbers were placed, there were three compartments—a manway 4 ft. 8 in. x 4 ft. 6 in. in the clear and two hoist compartments 4 ft. x 4 ft. 8 in. in the clear.



American Eagles shaft, Cripple Creek district, Colorado. Altitude, 10,750 ft.

Fig. 1 shows the shaft set and its dimensions. The corner posts are 10 in. x 10 in. and the center posts 6 in. x 10 in. The sets were placed on 6-ft. centers. There follows a list of the timber required for each set, including the posts and lagging:

Oregon fir:
- 2 pieces 10 in. x 10 in. x 16 ft., wall plates
- 2 pieces 10 in. x 10 in. x 6 ft. 4 in. end plates
- 2 pieces 6 in. x 10 in. x 4 ft. 10 in. dividers

Native yellow pine:
- 4 pieces 10 in. x 10 in. x 5 ft. 4 in. corner posts
- 4 pieces 6 in. x 10 in. x 5 ft. 4 in. center posts
- 42 pieces 2 in. x 10 in. x 5 ft. 10 in. lagging

The total lumber used in one set, including the lagging, is 1,054.8 bd. ft. To place the set there will have to be added about 100 ft. for blocking and about forty wedges. The cost of the lumber in the above complete set was $47.02. Average cost of framing the set, posts, and lagging was $12.

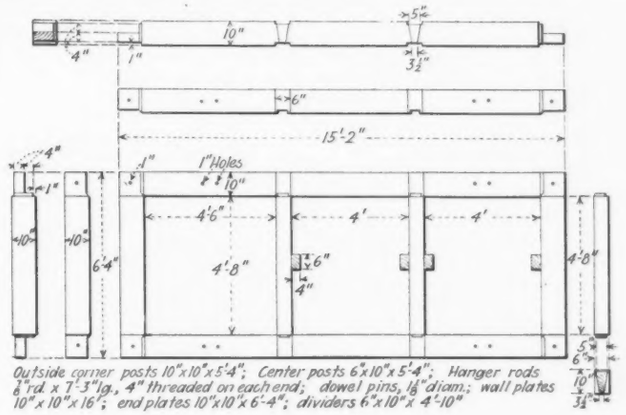


Fig. 1—Sketch of shaft set, American Eagles mine

The cost of the Oregon fir, at the mine, was $47.45 and the native yellow pine was $38.42 per thousand.

Fig. 2 shows the average round drilled. Round "A" was drilled and shot in one shift. The next shift mucked this round and drilled and shot round "B." Average time of mucking the forty-five buckets, about twenty-five tons, was five hours. Time of drilling the average round of fifteen six-foot holes was two hours and the time of loading was one hour. This method gave two half rounds or one full round mucked, drilled, and shot every day.

The rock was a well-sheared breccia with the shear at about right angles to the length of the shaft, except two flat sills of hard, black syenite each 15 ft. thick that crossed the shaft. The rock broke well with little over-break. The following tools and supplies were used.

Steel—One-inch hollow hexagon, Ingersoll-Rand "Sanvik," with 2¼-in. starters and 1⅛-in. finishers. At the start of this work 4,000 lb. of steel was made into drills of from 30 in. to 7 ft. length. At the end of the sinking the loss due to breakage and wear was 500 lb., or 12½ per cent.

Hose—Five ¾-in. unarmored hose were fitted with 1-in. standard-thread couplings, one male and one female type. The male end connected to a five-way pipe-fitted manifold with swivel connections. The female end was connected to the machine drills. Four hose extended to the machines and one to the blow pipe. These hose fittings have been adopted as standard for the mine.

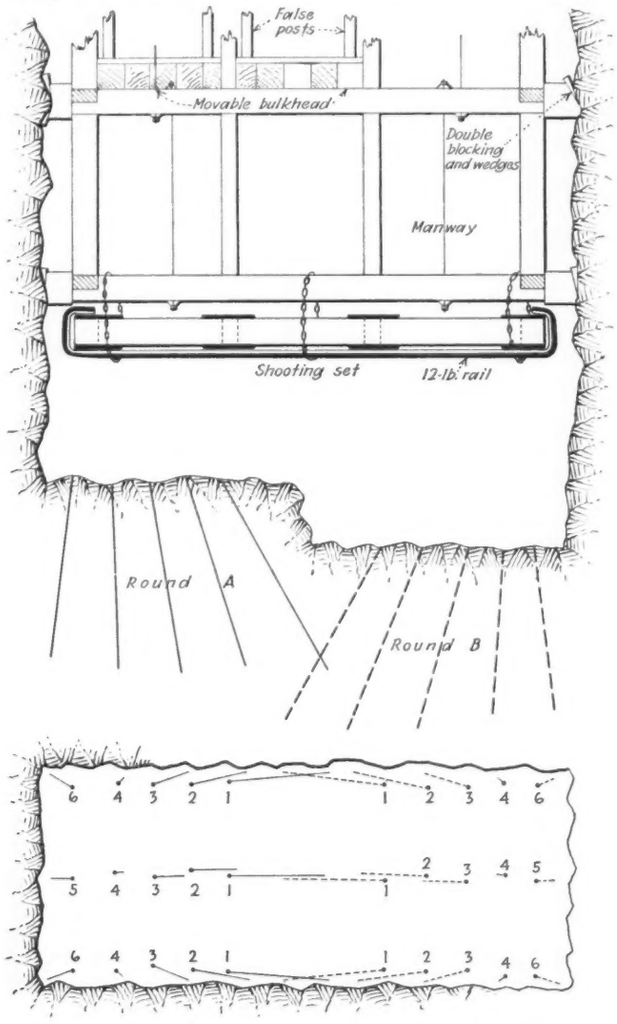

False posts
Movable bulkhead
Double blocking and wedges
Manway
Shooting set
12-lb. rail
Round A
Round B
6 4 3 2 1 1 2 3 4 6
5 4 3 2 1 1 2 3 4 5
6 4 3 2 1 1 2 3 4 6

Fig. 2—Movable bulkhead shooting set, and arrangement of shots

Powder—Low-freezing 40 per cent gelatine powder was used. The cost of this powder is $15.25 per 100 lb. at the mine. The average amount used was 6.75 sticks of 1⅛ in. x 8 in. per hole or 100 sticks (50 lb.) per half round.

Exploders—Giant Powder Co.'s delay-action electric exploders, with No. 6 caps and 8-ft. wires, were used. The average cost was 14.25c. each. As the mine is equipped with electric signals, current from the signal wiring at 120 volts was used for exploding. Two safety switches and a fuse were used on the blasting line, with an electric light placed between the switches. After loading was completed and everything in the clear, the fuse was put in and the first switch closed (Fig. 3). If the safety light burned the second switch was closed and the round fired. The total time required to explode the whole round, from the time the switch was closed until the last hole had gone, was 40 sec. Great care was taken in loading and connecting the holes, and in consequence there were only twenty missed holes while sinking 608 ft., or 0.3 of 1 per cent of the total holes loaded. At no time were the switches closer than 250 ft. from the blast. Lead wires were No. 12 double rubber-covered copper, and the connecting wire was No. 20 cotton-covered copper. As a precaution the lead wires were touched together for a test of no spark before connecting to the connecting wires; which showed that the switches were open above. The bottom was always wet on account of a heavy drip in the shaft from surface water. Pumping was unnecessary, as the sump at completion is 500 ft. above the Roosevelt drainage tunnel level.

Hanger Bolts—The hanger bolts used were ⅞ in. in diameter by 7 ft. 3 in. long, with square nuts and cast washers. The cost complete was $1.17 each. Four were used for each set of timber.

The sinking was done by contract, with the following conditions:

The company furnished the machine drills, hose, drill steel, steel sharpening, pipe, pipe fittings, shovels, picks, axes, hammers, saws, timber, wedges, lead wire, hoist and hoisting from the bottom to the surface, compressed air, and ventilation.

The contractor furnished the labor for drilling, mucking, timbering, and pipe work, and the explosives, connecting wire, and carbide.

Before sinking started a permanent solid timber bulkhead was placed two sets below the 1,500 level in the two main hoisting compartments: The manway compartment, which was used for the auxiliary hoisting, was completely blocked off from the rest of the shaft by lining and a second bulkhead above the sheave wheel. A movable bulkhead was placed on the second set from the bottom for the protection of the men below and the pipe fittings above. The shooting set, Fig. 2, was made of Oregon fir and protected at the corners and joints with ¼-in. steel plate, the remainder by 12-lb. mine rails strapped and bolted to the set. This one set lasted for the entire job.

Fig. 4 is a sketch of the sinking rig for handling the hoist and the top work with only one hoist man and no top man. As the bucket passed the collar of the level a four-way valve on the air-lift hoist was opened, allowing the shaft doors to close. These doors, *C*, were set overbalanced so that they would close by their own weight when released by the air lift. When the bucket had stopped the lever *A* was raised and the hinged dump apron, made of ¾-in. sheet steel, was allowed to come over the shaft just past the center of the bucket. The bucket was then lowered and dropped onto the apron, on which it slid until the chain and button caught in a V-shaped slot and turned over into the chute. The apron travel was governed by chain *B*. The muck slid directly into a waiting car, damage to which was prevented by log bumpers, *D*, suspended by chains.

After the round was blasted and the gases had cleared the next shift went down with two round-point shovels and two square-point shovels and two small steel sheets (15 by 30 in.). The first three or four buckets were mucked with round-point shovels until a flat space was gained large enough for the steel sheets.

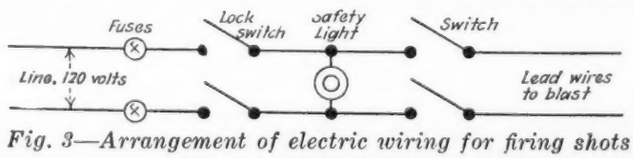


Fig. 3—Arrangement of electric wiring for firing shots

Then the sheets were placed and the rest of the round was mucked with square-point shovels. The average round mucked was forty-five 1,100-lb. buckets, and required about five hours. As soon as the bottom was picked and mucked clean the four machines, steel, and hose were lowered and a round averaging 15 6-ft. holes was drilled. This required about two hours. The holes were then blown out. About on hour was required for loading and connecting. As soon as the loading was complete and everything in the clear, the switches were closed and the round was fired.

The ground stood well, and usually it was possible to

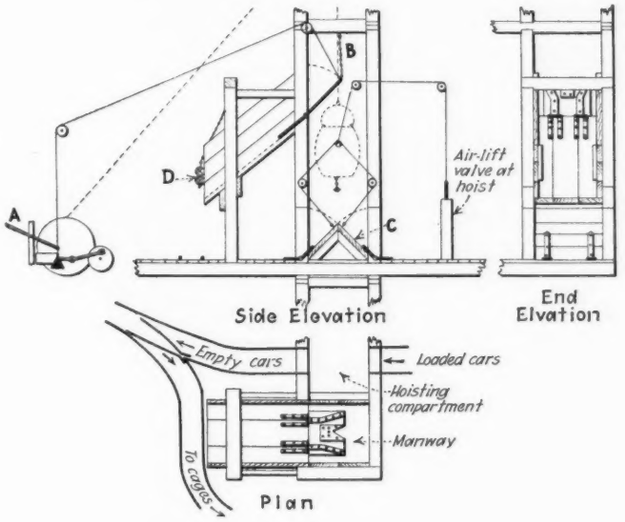


Fig. 4—Sketch of sinking rig at American Eagles mine

go the full length of the hose, 50 ft. below the bulkhead or 42 ft. below the last timber, before stopping for the new timber. Usually five sets of wall plates and end plates were hung and the dividers and posts set with everything ready for the blocking in one shift. The second shift then did the blocking, placed the lagging, bulkhead, pipe, and lined the hoist compartment.

Cutting and Timbering of Stations

Stations were usually cut when the point was reached, and after the cutting was complete the sump was sunk and the next lift started. On one lift the intermediate station was cut after the total 200-ft. lift was sunk. A long station set was placed, and when it was time to cut the station the posts were pulled and used as a bulkhead. The advantage of this type of station cutting is that there are no bad brows left for loose rock that are dangerous, as the timber is all placed and the sump complete before station cutting. Any loose rock can be blocked or pulled, as the distance is short. During the sinking of 600 ft. only one man was slightly injured (three days lost) and that was due to a rock that fell from a station brow while the sump was being sunk.

Fig. No. 5 is a photograph of a small-scale model of the station timber. This was designed by A. D. Walker, general foreman. Bearing timbers were placed two sets below the station on which the two sets were placed and blocked. Eighteen-foot sills were placed on the top set and the station posts placed on the sills. From this the station timbering was placed. The advantage of this design is that the timbering is so framed and tied that no portion can move unless everything else moves with it. Also the set, 16 ft. high, allows for the removal of rails, pipe and timber from the shaft without interference. This same set can be used on a single-side station.

The first lift was from the 1,500 level to the 1,700 level. As soon as the station was cut and the sump completed, the station was timbered and the crosscuts were started. When everything was clear and the tracks were laid, the auxiliary hoist and sinking rig were moved from the 1,500 level to the 1,700 level. The permanent bulkhead was moved to a point below the 1,700 level. The guides were then placed in the shaft, the ladders placed in the manway, and the signals connected. While completing the dump rig and fixing the shaft for another lift the crosscuts were pushed ahead as fast as possible.

The second lift was from the 1,700 level to the 2,100 level with stations at the 1,800, 1,900 and 2,100 levels. It was possible to do several hundred feet of lateral work on the 1,700 level while this last 400 ft. was being sunk.

Costs of Sinking and Timbering

Costs are divided into two parts, first those borne by the contractor and second those borne by the company, as shown in table at top of page 660.

The actual cost of sinking per foot was $38.751.

As a part of the contract a bonus was allowed for speed, and of course the greater the speed the larger

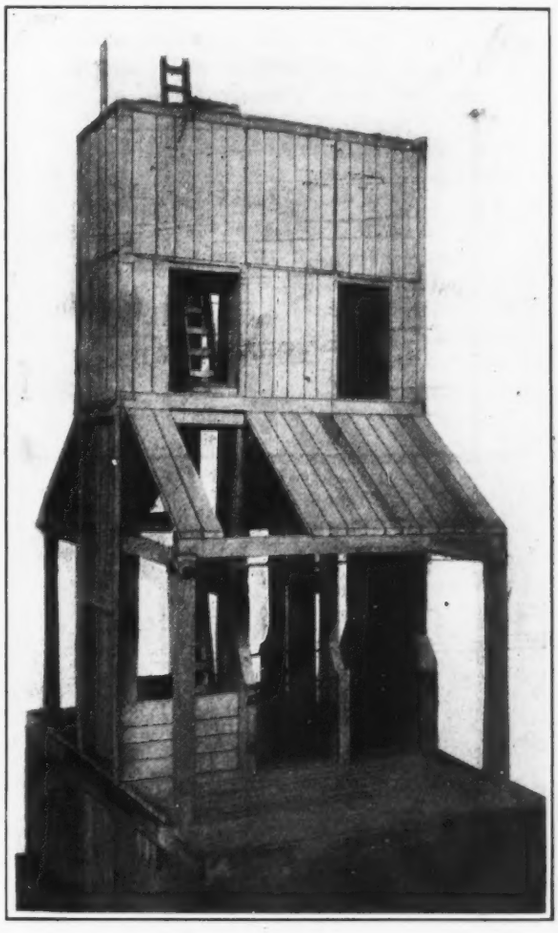


Fig. 5—Model of station timbering, American Eagles mine

the contractor's profit. The stations were cut and timbered on a separate contract. Costs follow:

(A) Contractor	Total Cost	Cost per Foot
Labor (four men per shift @ $7)	$9,855.64	$16.21
Powder	2,235.88	3.68
Connecting wire	11.69	.019
Delay electric fuses	536.78	.883
Carbide	98.40	.162
Total	$12,738.39	$20.954

(B) Company	Cost per Foot of Shaft
Bolts (¾ in. x 7 ft. 3 in.)	$0.780
Timber	7.985
Air line, 3 in.	.220
Ladders (16 ft. @ $3.20 each)	.266
Landings (every 12 ft.)	.050
Guides (4 in. x 6 in. x 24 ft.)	.604
Lagscrews (⅞ in. x 7 in.)	.020
Bell line (⅛ in. galvanized)	.220
Machine-drill repairs	.257
Hoisting (auxiliary) (two men at $5 and air $5 per shift)	5.595
Timber framing	2.000
Total	$17.797

Hauling Heavy Machinery in Cuba

Mine Operators Use Tractor and Bull Teams Drawing Specially Designed Wagon

HAULING heavy machinery over the difficult roads found in many mining regions is a problem frequently encountered. The following notes describe a task of this kind in Cuba, where the American Metal Co. operates at Matahambre the largest copper mine on the island. The mine is located in the Province of Pinar del Rio, on the northwest coast, the seaport being called "Puerto de Santa Lucia," but the mine itself is 15 miles back in the hills. The ore is taken from an underground deposit, with the primary crushing plant located at the headframe.

It was recently decided to increase the milling capacity by reducing the size of mill heads sent to the concentrator to minus ½ in., and for this purpose a set of 54 by 24-in. Traylor heavy-duty crushing rolls operating in closed circuit with Mitchel vibrating screens was purchased. The roll was delivered to the American Metal Co. at Carteret, N. J., and loaded upon its own ore boat for shipment to Cuba. The disassembled roll was lightered to Puerto de Santa Lucia from the ore boat, where the problem arose of hauling the heavy roll frame, weighing from eighteen to twenty tons, over an extremely bad road, with many sharp turns and some grades approaching 10 per cent.

The problem was handled successfully by D. D. Homer, manager of the mines, together with his engineering assistants, the attached photographs indicating the manner in which the frame was hauled.

A special wagon as shown in the photograph was constructed for bringing the frame to the mine. This wagon had 4-in. square steel axles diagonally linked together so that the rear axle "pivoted" the same degree as the front axle at all times, thus insuring that the hind wheels "tracked" with the front. This item was important because of the necessity of rounding sharp corners in the road.

To the wagon was hitched a 5-ton tractor, ahead of which was coupled twenty yokes of bulls. The tractor afforded complete steering control and the bulls helped to supply the pulling power. Three days was required to cover the 15 miles. The new addition to the crushing plant is now in satisfactory operation, giving results even better than originally expected.

Twenty span of bulls help the tractor

The roll base mounted on the wagon, and the tractor

Discussion

The Genesis of Chilean Nitrate

THE EDITOR:

Sir—Owing to my absence from the country for some months, there have just come to my attention the articles by James E. Harding on "The Andean Salares" and "Genesis of Chilean Nitrate" published in *Engineering and Mining Journal* for May 15 and May 29 respectively. That a new theory for the origin of the Chilean nitrate should be proposed shows that, despite the extensive literature on the subject, we do not yet have a generally satisfactory explanation. It is not likely, however, that this theory will bring us any nearer the goal.

Mr. Harding first reviews briefly previous theories, following largely, he says, the review by Singewald and Miller in 1916 in Volume 11 of *Economic Geology*, and concludes the review with a brief statement of the theory suggested by us. It is immaterial in this connection that this statement overlooks the essential point of our argument. His own theory is briefly this: The latest period of volcanic activity in the Andes covered the entire region with a thick blanket of tuff and volcanic mud. These volcanic materials carried within them "a large amount of gypsum, salt, some borax, and nitrates as well as other more easily soluble salts." The deposits are found "at any place where water was prevented from going deep into the ground by an impervious medium and was obliged to flow out on surface where it could be desiccated."

OBSERVATIONS OF SINGEWALD AND MILLER

Singewald and Miller pointed out in 1916 that a satisfactory theory of the origin of the Chilean nitrate deposits involved: (1), the explanation of the origin of the nitrate, and (2) the explanation of its localization into deposits of economic value. In our review of previous theories we called attention to the fact that at most they explained only how the nitrate might have been formed and did not attempt to explain its localization. We had no unequivocal evidence of the source or origin of the nitrate and, therefore, did no more than suggest some probable regional sources. As there are many nitrate-generating processes in nature, we felt it less important to speculate on which may have contributed the nitrate than to look for evidence that would explain how widely distributed nitrate had been localized into the commercial deposits. We suggested an explanation based on the combined favorable factors of climate, ground water, and geologic structure, that we believed obtained in the region.

In 1920, in *Economic Geology*, W. L. Whitehead disagreed with us and presented another theory. Irrespective of the extent to which one may agree or disagree with his conclusions, his paper represents the most thorough study and careful presentation of results that has been published to this day. He concluded that the nitrate is of volcanic origin and derived from Mesozoic lavas and tuffs that underlie the nitrate deposits, and that it was concentrated "by superficial, intermittent waters, causing slow downward migration of salts during the development of the present desert topography."

INACCURACIES IN THE HARDING PAPER

Mr. Harding's papers present no such array of geologic observations as was assembled by Whitehead, nor do they evidence a careful digest of the literature. In the very first paragraph he says: "Crude bromine and iodine are produced with the nitrate. Thus in the three important articles of commerce, sodium nitrate, bromine, and iodine, Chile possesses a natural monopoly." Grabau says in his "Geology of the Non-metallic Mineral Deposits" that bromine is absent, and I have not elsewhere seen Chile credited with a monopoly of bromine. Similar inaccuracies have crept into the geologic descriptions of the papers. The only direct evidence cited in support of the younger tuffs as the source of the nitrate is that analyses of water which leaches through them show a nitrate content. It is to be expected that waters seeping through any of the rocks of the nitrate pampa would show a nitrate content. One cannot conclude with any assurance that the nitrate had its origin in that rock. As indirect evidence he cites the support of Spurr, Lindgren, and Whitehead, for a volcanic origin. But their ideas are not "the present advocated volcanic origin" as believed by the author. In his "Ore Magmas" Spurr refers to a volcanic origin in a general way, mentioning hot springs and volcanic vapors as possibilities. In his editorial in the *Engineering and Mining Journal* of Dec. 2, 1922, Spurr suggests volcanic outbursts mixing the air with vomited gases, including abundant nitrogen, transference of this nitrogen to the soil by violent rains due to the condensation of water-gas, and "later concentration at the atmosphere-rock contact and reaction zone by the 'drawing' of the sun's rays." This is quite a different mode of volcanic origin from that postulated by the new theory. Lindgren, in his "Mineral Deposits," and Whitehead, regard the Mesozoic volcanics as the source of the nitrate and rule out the younger volcanics. The conclusions of Spurr, Lindgren, and Whitehead lend support only to the possibility of a volcanic origin, but do not help to establish the conclusion that the younger tuffs and volcanic muds were actually the source. Clarke, in his "Data of Geochemistry," has already assembled enough geologic observations to establish the possibility of volcanic origin. But because nitrates may be of volcanic origin does not suffice to prove that the younger volcanic materials were the source of the Chilean nitrate. Whitehead and Lindgren believe they were not.

The description of the localization of the nitrate also does not conform with its occurrence as described by other observers. Rogers and Van Wagenen, in volume 59 of the *Transactions* of the American Institute of Mining Engineers, say the nitrate is underlain by loose,

unconsolidated, fine gravel and sand. Whitehead's diagrams show the *caliche* underlain by gravel. It is also covered by a thin mantle of such material. On these points all other descriptions are in accord. Hence it is not likely that an explanation based on the desiccation of water coming to the surface from bedrock or flowing along the surface of a nearly impervious clay stratum will be acceptable.

Comments on Whitehead's Paper

While on the subject of Chilean nitrate, I would like to add a few comments on Whitehead's paper. Mr. Whitehead devotes a part of his paper to a discussion of the theory suggested by Singewald and Miller. In that paper we had two objectives. During a brief visit to a part of the nitrate region, we were struck by the fact that all previous attempts to explain those deposits had been merely speculations as to how the nitrate might have been generated. The first objective of our paper was to point out that even were that question solved, there remained untouched the equally important question of the localization. Because of the position of the deposits in the part of the nitrate region we visited, we believed the localization was explained by the combination of favorable factors enumerated in our theory. The second objective of our paper was to present that explanation. If, as contended by Whitehead, the facts of occurrence in other parts of the nitrate region are not in accord with the premises of the theory, the latter is not a generally applicable theory. The arguments he advances against the theory, however, are not so conclusive. There is considerable exaggeration in his statement that processes "by which salts may migrate a few centimeters up the walls of the containers of their solutions have been called upon by the authors to perform the astounding feat of the transportation of nitrate several kilometers through gravels." The theory hardly calls upon these processes to transport nitrate hundreds of meters, and for the most part calls for much less. Furthermore, however ineffective the processes we have called "efflorescence" or "crawling" may be argued to be on theoretical grounds, that some such process is operative where desert conditions prevail is indicated by the widespread occurrence of *caliche* in desert basins. The process is similar to that referred to by Spurr as the "drawing" of the sun's rays. In Chile, the *caliche* has the distinguishing characteristic of a large amount of nitrate.

With respect to Whitehead's theory that the Mesozoic tuffs and lava flows are the source of the nitrate, my position is agnostic. The evidence adduced is very indirect and inferential. Because nitrates may be of volcanic origin and because he found the nitrate deposits to be confined to the outcrop area of the Mesozoic volcanics, he concludes that they were the source of the nitrate. The validity of the conclusion rests largely on the validity of his theory of accumulation. If the latter is correct, the former is very plausible. But I am not convinced of the correctness of the mode of accumulation described by Whitehead.

Effect of Gravitation and Other Forces

The source of the nitrate, he says, is upon the hilltops and steep rocky slopes, and its concentration resulted from a slow downward migration of the salts. But that migration had both a downward and a horizontal component. The forces that might have caused the migration are gravity and capillarity. He says "capillarity may account for some slight transportation of solutions, but . . . the process will be interrupted and of no great importance." As he excludes capillarity, the effective force causing the migration must have been gravity. It is difficult to understand how salts migrating in solution through gravitational force down slopes with a predominant horizontal component can secure that component except along the bedrock surface. If the salts started on the upper rocky slopes, descended to the lower gravel-covered slopes, and continued their downward migration, must that migration not have been in the lower part of the gravel fill along the bedrock rather than in the upper part of the gravel close to the surface as shown in Whitehead's diagrams? Every time nitrate was taken into solution by "superficial, intermittent waters," gravity was pulling those solutions toward bedrock. It does not seem possible that those solutions could have accomplished the great horizontal movement from the tops of the hills to the lowermost slopes, and yet have escaped the small vertical descent to bedrock through the "fractured rock or gravels not cemented" that underlie the *caliche*. Gravity alone does not seem adequate to explain such a migration of the nitrate as described. Other forces that can overcome the tendency of gravity must have been operative, forces of the nature of "capillarity," or "crawling," or "drawing." If that must be conceded, then the migration of the nitrate might as well have been up the slope as down the slope, and much of the presumption in favor of the hilltops as the source of the nitrate disappears.

Although Whitehead has studied the problem more thoroughly and has accumulated more evidence than any other writer upon the subject of the genesis of the Chilean nitrate deposits, and although he has clearly recognized the two problems involved in a satisfactory theory and has presented a solution for each, the chain of his argument is linked to too great an extent with indirect evidence and interpretation of observations, and his conclusions are not sufficient to settle finally this long-disputed problem of genesis.

JOSEPH T. SINGEWALD, JR.
The Johns Hopkins University,
Baltimore.

Too Much Dictatorship in California

THE EDITOR:

Sir—I note the letter in your issue of Sept. 18 answering the editorial that appeared Aug. 31 regarding the California blue-sky law. I want to add my weight to the sentiments expressed in the letter, having had some experience with the arch duke or arch fiend of this glorious state, known as the State Corporation Commissioner. I have been nine months getting a permit to sell 50,000 shares of stock. As a sample of governmental efficiency, I sent, on Aug. 30, the filing fee of $45, and it took twenty-five days to make out a receipt for it! Send them an affidavit and they send back for a plain statement, not sworn to. Anything to delay and aggravate.

The law is vicious and un-American. No one should make such decisions as the commissioner is called on to make. It makes a real dictator out of him. I approve fully Mr. F. Albert Morrison's letter.

Keeler, Calif. STEPHEN CHAPLIN.

News of the Week

The Mining News given in ENGINEERING AND MINING JOURNAL is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary

COPPER EXPORTERS, INC., authorized by Federal Trade Commission—Government selects site for potash exploration—Canada accumulates gold at Ottawa.

New mining law in Mexico meets opposition in the National Chamber of Mines; Secretary of Commerce defends law and regulations.

Tin chief topic in London market—Johannesburg Consolidated platinum shares stimulated by recent annual report.

Beaver Consolidated declares dividend of Kirkland Lake Gold stock, and elects new directorate—Rouyn railway nears completion.

Aluminum cartel of European producers — Spanish iron mining depressed—New gold reef reported near Rustenburg, South Africa.

Bonney Mine, Lordsburg, N. M., reopened by Phelps Dodge Corporation — Comstock Silver and San Rafael making regular shipments—Central Copper starts new mill.

Scranton capital invested at Basin, Mont. — North Butte leasers ship 3,500 tons per month—Butte Copper Consolidated sells claims.

Guggenheim dredge begins work on Bolivian tin — Texas sulphur shipments increasing—First oil well in Saskatchewan.

Michigan College of Mines studies copper losses—Lake mines prepared for large production.

Total value of Utah metal production reduced 1.5 to 2 per cent by lower silver prices.

Inspiration Starts 7,500-Ton Leaching Plant

Should Effect a Reduction of Two Cents per Pound of Copper Produced

LEACHING of oxidized ore at the Inspiration plant is under way on a basis of 5,000 tons per day. The maximum capacity of the plant is 7,500 tons a day.

It will take probably two months to get the solutions built up sufficiently in ferric sulphate to treat mixed oxidized and sulphide ores efficiently. At present the company is working with sulphuric acid and ferrous sulphate solutions, and treating only highly oxidized ores. Gradually through the action in the precipitation tanks ferrous sulphate is converted into ferric sulphate as the copper is precipitated from solution. When the ferric sulphate is up to working strength the process will treat, with high recoveries, ores containing fair percentages of sulphides along with the copper in oxidized forms.

The new plant consists of the crushing plant and 13 leaching tanks, 70 x 175 x 18 ft. deep, holding 7,500 tons each. Ore is crushed to ⅜ or ¼ inch before being charged. In the tanks the ore is leached twelve days with a solution containing 5 per cent to 7 per cent sulphuric acid and 1.1 per cent iron in form of ferric sulphate. The process is new, having been especially devised to treat ores containing copper in both oxidized and sulphide form.

By the first of the year the new process should be working smoothly on mixed ores with all the troubles of a new plant ironed out, and output capable of being increased to maximum whenever consumption and condition of the market warrant it. The capacity of the plant is about 45,000,000 lb. of copper a year, treating present Inspiration grade of ore.

Last year, treating ore averaging 1.038 per cent copper, Inspiration's cost of producing copper, using flotation in milling the ore, was 12.28c. a pound, including depreciation and all charges except depletion. Treating normal grade of ore the leaching plant should produce copper for materially under 10c. a pound.

Inspiration is at present producing about 7,500,000 lb. of copper a month from sulphide ores. These are coming partly from the Live Oak end of the property and partly from the Inspiration side of the fault. The company has overcome the difficulties met with in caving the ore at the Live Oak end due to the greater moisture, and the mining costs are reduced materially.

Inspiration has roughly 95,000,000 tons of ore devolped averaging 1.4 per cent copper. Operating the leaching plant at capacity and treating about 5,000,000 tons of sulphide ore a year by flotation, the property has a life of roughly 12 years. The company has outstanding $6,000,000 6½ per cent gold notes due March 1, 1931. It is paying at present 50c. a quarter in dividends.

Mines Supply More than Half of Railroad Freight

More than one-half of the total freight originated by the Class One railroads of the United States during the second quarter of 1926 was contributed by mines. Products of mines to the extent of 181,962,780 tons were shipped during the quarter ended June 30, 1926. This is an increase of 8.2 per cent over the tonnage furnished by mines in the corresponding quarter of 1925. The separate items making up the total tonnage furnished by mines during the second quarter of 1926, are as follows:

	Tons
Anthracite coal	22,574,108
Bituminous coal	79,987,369
Coke	5,101,595
Iron ore	21,098,389
Other ores	3,224,381
Bullion and matte	219,257
Clay, gravel, etc	43,935,653
Crude petroleum	2,617,991
Asphalt	827,373
Salt	763,261
Other products of mines	1,613,403
Total	181,962,780

Stewart Campbell Wins Jury Verdict in Mine Libel Suit

Stewart Campbell, Idaho state mine inspector, won a federal court jury's verdict of acquittal, at Boise, Idaho, Oct. 14, in the $500,000 libel suit brought against him by the Idaho Copper Corporation, a George Graham Rice promotion. A sudden ending came to the trial in the afternoon, the plaintiff abruptly terminating the introduction of evidence and the defense resting without the submission of any after Judge Frank S. Dietrich had prepared for an ensuing session. The jury returned a verdict of acquittal.

Aluminum Cartel to Include Principal European Producers

Through the efforts of leaders of the German aluminum industry, another Continental trust has been formed. A tentative agreement has been reached and France will probably be included before the cartel becomes operative.

The formation of this combination will be another coup for German business. Being a dominant factor in the aluminum trade, Germany, instead of carrying on the fight for world markets single-handed, will have the financial and productive power of the cartel behind her. Other members—probably Switzerland, Holland, and Belgium—will benefit, but Germany will be the most fortunate one in the agreement.

The purpose is not to increase prices and restrict production, but rather to increase production by invading the world markets.

Colorado Mining Notes

The La Plata Mining Co., La Plata, Colo., is extensively developing its mine known as the Bonnie Girl, near Durango, Colo., with M. S. McCartney in charge. He is working a force of fifty men, erecting a mill, bunkhouses, office buildings, and a boarding house, and also constructing a flume to carry water to a hydro-electric plant, and repairing the aërial tramway leading from the mill to the company's Gold King mine. Operation of the mill is expected by Nov. 1.

The Empire Chief Mining Co., Silverton, Colo., with properties near Silverton, has installed a compressor and a concentration and flotation mill of 100 tons' daily capacity, and is securing excellent results as well as good tonnage.

The largest discovery in the history of Aspen, Colo., was recently made when a very high-grade silver and copper ore and a small percentage of lead was found in the Mary B. mine. The mine is privately operated by Thomas F. Hines, of Aspen, who is also the principal owner. The stope where the ore was found is on the 100-ft. level at the end of a 130-ft. drift and is a part of a 9-ft. vein discovered at the 150-ft. level several weeks ago. As a result of the announcing of the find there has been quite a rush of prospectors, which is reminiscent of Aspen's former days.

Gladstone Paying Dividends Regularly

Gladstone Mining Co. had a surplus of $142,743 on Oct. 1 after paying all September bills, this surplus including seven cars of ore in transit, valued at $4,500 per car, according to H. W. Fairbanks, of Spokane, secretary of the company. James S. Ramage, of Spokane, is president.

This is a substantial showing after a dividend period of 20 months without interruption. The dividends have totalled $145,420, disbursed to 1,322,000 shares. A new working shaft will probably be started this month to develop new ore areas recently uncovered. This will be more economical than running a 1,000-ft. crosscut from the last orebody.

Carbonate ores in the Gladstone last year averaged 22.3 per cent lead, Mr. Fairbanks says, the average lately is well above 30 per cent. The property is in northern Stevens County, State of Washington.

Experiments to Eliminate Sulphur From Iron Ore, and Reduce Copper Losses Under Way

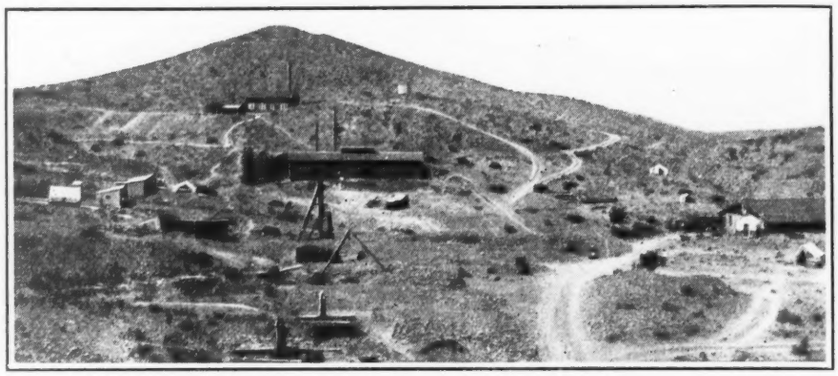
Experiments important to the mining industry generally and to iron and copper producers particularly, are under way at the Michigan College of Mines, Houghton. Progress is being made in tests to eliminate sulphur from iron ores, the problem being to do this work cheaply. There are millions of tons of iron ore containing a high percentage of sulphur which are practically useless under present methods. In copper research work, experiments are being conducted to reduce the percentage of gangue in copper mineral and loss of copper in tailings or waste sand. In treatment of amygdaloid copper rock, five pounds or more of metal per ton are lost by present milling methods. Regrinding reduces the loss somewhat, but the percentage still is considered too high. Regrinding experiments now are in progress to discover if possible some law which will govern the treatment of rock of varying degrees of hardness. For this purpose, material will be taken from every mill in the district. A standard ball mill is being used, with a definite weight of flint pebbles, revolving for a fixed time. Material of definite size is being screened out on Tyler standard screens. This operation is repeated four times with the same material and the entire series of experiments will continue over a considerable period to afford opportunity for a new screen analysis. Rock from all producing mines in the Michigan district will be tested. The mining companies are co-operating in this work.

Subsidiary of St. Joe Lead in Mexico

The Linares Mining Co., a subsidiary of the St. Joseph Lead Co., has been organized in Zacatecas for the purpose of taking over properties on option for examination.

Reopening of Bonney Mine Stimulates Lordsburg District

The interest shown by the Phelps Dodge Corporation in the Bonney mine, at Lordsburg, N. M., is having its effect, and the district is attracting much attention from mining men and promoters. A number of outside claims have changed hands, and the operating companies have been active in "blocking" their holdings. Claims with good showings that have lain dorment for years are being cleaned out and new work is to be started. All of the ground (about 600 acres) adjacent to the 85 Mine, in the southwest and surrounding the Bonney, is under options held by Foster & Porteus, of Lordsburg.



The Bonney Mine, Lordsburg, N. M.

Three shifts are at work retimbering No. 2 shaft at the Bonney Mine, Lordsburg, preparatory to unwatering, so that examination of the lower levels may be made by the Phelps Dodge engineers. Four 50-ton cars of ore shipped from the 375-ft. level of No. 1 shaft during September gave net smelter returns of $24.05, $24.35, $31.17, and $41.23 per ton. This vein, which runs parallel to the big vein opened in No. 2 and No. 3 shafts, has never been cut except in No. 1 shaft, though it is clearly indicated to run about 100 ft. to the north. Work will be started at an early date to pick up this vein from the 500-ft. level of No. 2.

Should the final reports on the Bonney prove satisfactory (and excellent authority contends that this is probable) work will be started at once in deepening No. 2 shaft. A complete working force as well as an entire new mechanical equipment will be needed at an early date.

The Calumet and Arizona, which owns and has operated the 85 Mine successfully, is reported to have purchased the Cobra Negra group of three patented claims, from the Susquehanna Copper Co., of Bellefont, Pa. This property covers the southwest extension of the superior vein of the 85 Mine, and will give the company an additional 3,000 ft. on that vein, which has been very productive. The same company is also reported to have an option on the Atwood ground which joins the 85 Mine on the northeasterly end and is of approximately 100 acres in extent. The ground is opened by several shafts to a depth of 300 ft. and is conveniently located for transportation.

Completion of Big Arizona Projects an Aid to Mining

October marks the formal opening of the new main line of the Southern Pacific through the Florence-Casa Grande, Salt River, and lower Gila valleys. This new construction work, which has cost $15,000,000, places the town of Phoenix on the main line of the Southern Pacific.

The $6,000,000 leaching plant of the Inspiration Consolidated Copper Co. is now completed and will be in full operation at an early date.

The $1,250,000 reconstruction job at the Douglas smelter of the Phelps Dodge Corporation is to be completed the first of the year. A large saving will be effected through these changes, as it will then be possible to eliminate the use of coke for fuel, which is at present being supplied by the Dawson coal mines at a high cost. Reverberatory smelting will be used entirely, and oil will be the only fuel.

The $4,400,000 Horse Mesa power dam of the Salt River Valley Water Users' Association will be finished next spring. The entire output of power from this plant will be used by the Inspiration leaching plant.

Bids for the construction of the $5,500,000 Coolidge Dam at San Carlos, according to last reports, are to be called this month. Preliminary construction has been under way for some time.

Scranton Capital Invested at Basin, Mont.

Engineers are now completing the survey and mapping of a group of some seventy claims (1,400 acres in the Basin, Mont., district) recently taken over by William H. Hax and associates, of Scranton, Pa. The engineering work has been under the supervision of E. J. Strassburger, of Butte. The claims lie on the west side of High Ore Gulch and south of the Grey Eagle group, about two miles east of Basin, Jefferson County. It is proposed to drive a crosscut tunnel with ultimate length of 15,000 ft. to tap 35 veins which are exposed on the surface and from a great many of which commercial ore has been extracted. The surface ores are a mixture of copper-lead-zinc-silver sulphides and some of the veins have high gold values.

A two-mile electric power line will be extended from Basin to the portal of the tunnel, which is close to the Boulder River and a few hundred feet from the tracks of the Great Northern Ry. According to engineering data, the tunnel will have a depth of 1,500 ft. below the surface at its northern point. Operations will be in charge of Carl J. Trauerman, Butte mining engineer.

Michigan College of Mines to Change Name

The board of control of the Michigan College of Mines at Houghton has endorsed the recommendation of the alumni that the name of the institution be changed to "The Michigan College of Mines and Technology." The legislature will be asked to make the change. The new name is desired to indicate the broad scope of the engineering courses available at the college.

Michigan Copper Mines Ready for Large Production

The mines of the Michigan copper district are in condition to take advantage of an increase in price of metal. Throughout the lean years, since 1918, they have made notable improvements to reduce operating costs and introduced more efficient methods in every branch of copper production. Many thousands of feet of openings have been added to copper reserves. Considerable attention has been paid to exploratory work during the period of the depression, particularly by Calumet & Hecla, which is continuing this policy. Recently there has been a revival of interest in Keweenaw County, and that part of the district will be the scene of some important development projects.

Comstock Silver Making Regular Shipments

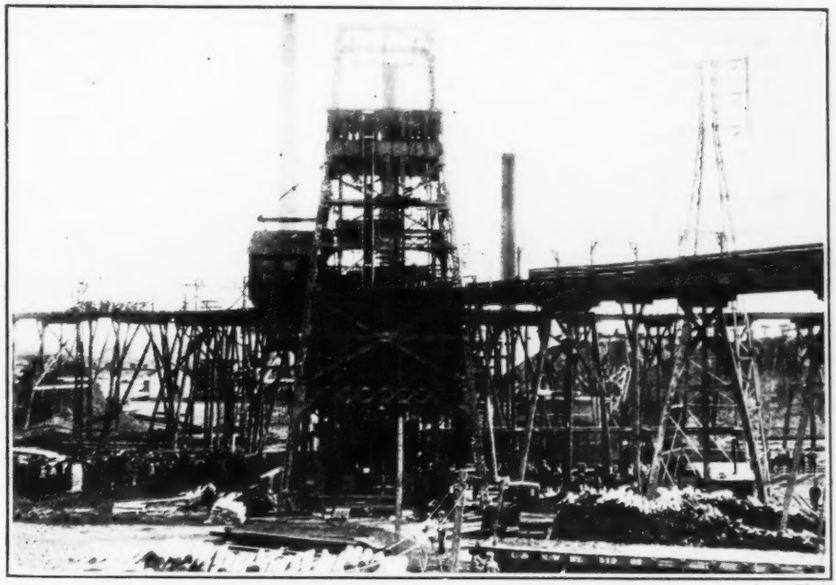
According to General Manager F. W. Manson recent development work at the Comstock Silver mine has given the property ore reserves of 300,000 tons of an average grade of $35 per ton. The property is located at Stockton Hill 12 miles north of Kingman, Ariz. In the Premier tunnel the vein has been followed for a distance of 145 ft. The average width is 14 ft., of which 6 ft. is of shipping grade and the remainder of milling grade. Preparations are being made to raise from the tunnel level to an intermediate level 75 ft. above. Present production is at the rate of five cars of ore every two days. The value of each five-car shipment is said to be around $14,000. The ore is transported to Kingman by a fleet of 10 trucks.

North Butte Leasers Ship 3,500 Tons per Month

Leasers at the "Hill" properties of the North Butte Mining Co. shipped 3,500 tons of ore in September, 125 men being employed by the twenty-two sets of leasers under-ground. The Granite Mountain shaft is being slowly unwatered, the water now standing at the 2,900 point. In order to lease out blocks of ore left from former operations above the 1.600 level, the company is cleaning out drifts and timbering.

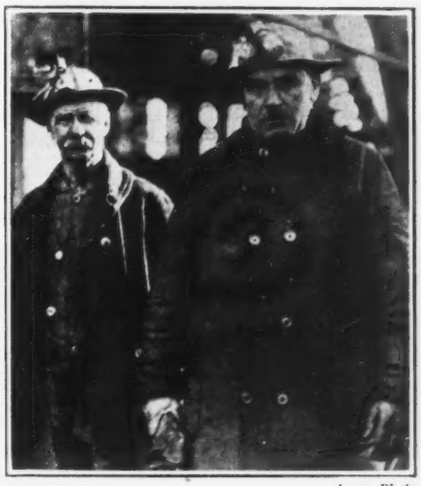
Leaching Solvents Developed at Tucson

A cheap solvent for leaching certain ores containing mixed oxides and sulphides of copper has been developed in the laboratory of the Southwest Experiment Station of the U. S. Bureau of Mines located in the University of Arizona at Tucson. The solvent is now being tested on a commercial scale in the Globe district. The new reagent, according to Supt. E. D. Gardner, is expected to reduce the cost of treating certain types of ore which heretofore



Acme Photo

Pabst mine shaft, Ironwood, Mich., where forty-three men were imprisoned by a cave-in, and from which they were rescued



Acme Photo

Leaders of rescuers at the Pabst mine

Albert Nichols (left) was in charge of the timber work in the wrecked shaft and Capt. G. A. Erickson (right) had complete charge of the rescue operations to save the forty-three men imprisoned by the cave-in Sept. 24, 1926. See page 581 of Oct. 9 issue of *Engineering and Mining Journal* for details.

could not be exploited on account of the expense. To obtain the new solution gases from the roasters are run through a solution containing ferrous sulphate. The sulphur dioxide from the roasters converts the ferrous sulphate to the ferric form, which dissolves some of the sulphide minerals and forms sulphuric acid, which in turn dissolves the oxide minerals.

The station is also conducting experiments to produce a more refractory material than that at present used for lining reverberatory furnaces, to reduce losses of copper in slags and to recover the metallic contents from flue dust by hydrometallurgical methods. Another problem which is being studied is the leaching of copper from the middling products of concentrators.

Central Copper Company's Concentrator Makes Initial Run

The newly constructed concentrator of the Central Copper Co., located at Dos Cabezas, Ariz., has been given a trial test, and is reported to have operated smoothly and entirely to the satisfaction of the officials of the company.

Sufficient water has been developed at Dos Cabezas to assure the continued running of the mill two shifts every day. The company has just completed the construction of a long tramway from the Elmo shaft to the new mill. The tramway when it is placed in operation will be one of the longest aerial conveyors in the state. A spur of the company's railroad at Dos Cabezas has been laid to the mill and will haul all the necessary supplies and fuel. Over $1,000,000 has been spent during the past year in the construction program of the Central Copper Co.

Guggenheim Dredge Operating on Bolivian Tin

The firm of Guggenheim Bros. has completed the equipment of a property near Potosi, Bolivia, for the dredging of tin. A dredge was ordered from the Yuba Manufacturing Co., San Francisco, and was placed in successful operation on Sept. 15. Since that time the results have been entirely satisfactory. This is the first tin dredge that has been put in service in Bolivia by an American company.

Texas Sulphur Shipments Increasing

During the twelve months ended Sept. 30, 1926, a total of 1,214,513 tons of sulphur was shipped through the ports of Galveston, Texas City, and Freeport. This was an increase of 281,225 tons, compared with the water shipments for the corresponding twelve months of 1925. Of the total movement through these ports during the year 451,783 tons was exported to foreign countries.

Monthly sulphur export records were broken here in August, 1926, when 100,644 tons of sulphur was shipped out of Galveston alone. This was the biggest movement for one month on record from this port.

Value of Utah Metal Production Not Seriously Reduced by Silver Prices

By Gail Martin
Salt Lake City, Utah

Revenues of the Utah non-ferrous metal industry will not be affected in any appreciable degree by the drop in the price of silver. Three factors contribute to maintain the prosperity of Utah mining on a stable basis:

First, the high price of lead more than offsets the loss in the price of silver. It is estimated that a 1c. increase in the price of lead offsets a twelve point drop in silver. In the case of the Park Utah Consolidated Mines company, a 1c. increase in the price of lead offsets a loss of 18½c. in the price of silver.

Second, the increase in the production of zinc will more than compensate for any loss of revenues to the industry through the weakness of silver. Zinc production, it is computed, will this year be three times that of last year. The increased revenues from zinc, formerly penalized by smelters, will this year offset a 10c. loss on an output of silver equaling that for 1925, the largest in the history of the state.

Third, the strong cash position of Utah mines guarantees that any depression will be weathered, development work continued, reserves expanded, and mines put in condition to take advantage of rising metal quotations.

Last year, Utah produced 21,276,689 oz. of silver. The average price was 69c. The average price for the first nine months of the current year is approximately 63c. Estimated on last year's silver production and allowing a 6c. loss to the ounce of silver, due to lower prices, Utah mines are earning at the rate of approximately $1,250,000 annually less this year as a result of the decrease in white metal quotations. Compared with the total non-ferrous metal production for 1925 amounting to $82,701,394, a loss of $1,250,000 annually from a lower price of silver amounts to only 1.5 per cent of the total income accruing to mines of the state from the sales of metal.

As an illustration of what the drop in silver means to the individual mine, a study of the finances of two Utah mines is helpful. The Tintic Standard, which produces more silver ore from one shaft than any other company in the state, shipped last year a gross total of $7,116,629 worth of ore. The silver output aggregated 4,080,878 oz. and lead 48,072,818 lb. Should the average price of silver for the current year be 10c. less than last year's, using the output for last year, the loss in Tintic Standard income would be $400,000 or hardly more than 5 per cent of the total income. Even with silver at its present level, the company is earning more than enough each two months to pay regular quarterly dividends at the current rate of 40c. a share. In addition, the company has more than $4,000,000 in cash and bonds and over $700,000 in well-secured loans.

The status of the Park Utah Consolidated Mines Co., Utah's largest silver-producing organization, is fully as sound. Each cent variation in the price of silver means but .764 of one per cent profit variation for the Park City unit and but .93 of 1 per cent for the Park Utah unit. Park City unit ore having a value of $1,000,000 with silver at 62c. represents a net value at the mine of $969,000 with silver at 57c. Ore of the Park Utah unit having a value of $1,000,000 with silver at 62c. has a value of $953,000 with silver at 57c.

Increase of the milling facilities of the Silver King Coalition Mines Co. will enable the company to earn more from the sale of zinc concentrate than it is losing through lower quotations for silver.

San Rafael Makes Regular Shipments from Development Work

The San Rafael Development Co. is shipping two cars of ore per week from its Quartz Mountain property, in Nevada, and has maintained that average since early in April, when it made its first shipment after taking over the mine on the expiration of the Walker-Annette lease. A large proportion of the ore has come from development work. Development has been pushed as rapidly as possible with present equipment, and results have been very satisfactory. The company has deepened the incline shaft to 400 ft., established levels at 250 and 350 ft. and accomplished considerable lateral work from the various levels. It is estimated that the incline shaft will cut the intersection of the flat and vertical veins within 60 ft. The area in the vicinity of the intersection should prove to be a favorable locality for the finding of large ore deposits. Important developments are expected in the San Rafael property within the next sixty days.

Many near-in companies are engaged in shaft sinking, with no developments of importance reported or expected. Most of the shafts are vertical, and it is not likely that these companies will open anything of interest until lateral work is started. The Calico shaft, northwest of the San Rafael, is down 130 ft., and the first station is to be cut at 200 ft. The Quartz Mountain Metals, which owns property to the southeast of the San Rafael, is well financed for preliminary work. New surface equipment is being installed, and the Murphy shaft will be deepened to 400 ft.

Butte Copper Consolidated Sells Twelve Claims

A group of Montana mining men has sold to an Eastern syndicate the properties known as the Butte Copper Consolidated Mines, consisting of twelve full claims, lying in township 4 N, R. 6 W., two miles south of Trask, Jefferson County, Mont. The property, from which copper-silver ore was shipped, was recently favorably reported on by two Butte mining engineers. It is developed by central shaft, 100 ft. deep, which will be deepened. Initial work will be done with a steam plant to be furnished by the Butte Machinery Co. Colonel A. P. Peake will be in charge of operations.

Washington News

By Paul Wooton

Special Correspondent

Copper Exporters, Inc., Authorized—Bolivia to Develop Highways

The long-expected action of the copper producers in forming an export association under the Webb-Pomerene Law was taken Oct. 13. Following the filing of the necessary papers the Federal Trade Commission gave out this statement:

"The Copper Exporters, Inc., 25 Broadway, New York City, has filed papers under the Export Trade Act (Webb-Pomerene Law) with the Federal Trade Commission, for the purpose of exporting copper and copper products.

"The Export Trade Act grants exemption from the anti-trust laws to an association entered into and solely engaged in export trade, with the provision that there be no restraint of trade within the United States, or restraint of the export trade of any domestic competitor, and with the further prohibition of any agreement, understanding, conspiracy or act which shall enhance or depress prices or substantially lessen competition within the United States or otherwise restrain trade therein."

The names of the officers and members of the organization were given in *Engineering and Mining Journal*, Oct. 16.

Bolivian Highways

An effort is being made in Bolivia to develop a comprehensive highway system. Thus far railroads and highways have been provided only when mining development has made it imperative. The thought now is that a good longitudinal highway with numerous branches into mineralized areas will stimulate mining.

Bolivia's transportation developed as follows: The Huanchaca company continued the Nitrate road from Chile to Pulacayo and Oruro. Oruro subsequently was connected with La Paz and Cochabamba. A line just has been completed from Uyuni—the station on the main line where the line to Pulacayo branches off—to the Argentine border at Villazon, connecting with the Argentine railway.

Some desultory work has been done on a road from La Paz to the interior, but only a short distance has been built. Construction of a road connecting Potosi and Scure is under way, but it is far from completion.

Recently the Guggenheims constructed a truck road to their Caracolas properties from Eucaliptus station, on the line between Oruro and La Paz. The Araca company built a truck road from its mine to the Guggenheim road. Other than these, there is practically no year-around transportation in Bolivia.

Therapeutic Properties of Radium

An evidence that the therapeutic properties of radium are becoming widely recognized is seen in the increasing number of requests for the use of the radium belonging to the U. S. Bureau of Mines.

Because of the demand for the use of this radium an investigation has been made which reveals that it is being used to capacity. The Bureau owns two grams, which it produced in the course of its pioneer work in radium production. The Bureau's radium is being used overtime, every day, in a Baltimore hospital.

Texas Potash

A group of Texans who financed the drilling operation near Midlands, which cut a 7-ft. bed of 16 per cent potash at a depth of 2,000 ft., were in the East last week looking for advice as to the next step they should take. They discussed the matter with Secretary Hoover and Director Turner, in Washington, who advised them to seek the advice of competent engineers. This led to various conferences in New York, but no definite plan for developing the property has been worked out.

Government Selects Site for Potash Exploration

The area officially selected for the beginning of the Federal Government's effort to find domestic supplies of potash lies in the northwest corner of Section 4, William Teer survey, Upton County, Tex., and centers about the Dixie Hughes No. 1 oil well, according to the Bureau of Mines. This area, which has been recommended by the U. S. Geological Survey for potash exploration, is located in a territory now developing as an oil field, oil production being obtained at an average depth of 2,000 ft. The depth to the top of the potash-bearing salts is 435 ft. Total depth recommended for test holes is 1,300 ft. Mineralogical examination of a series of cuttings shows three horizons of excellent polyhalite.

Under the provisions of the enabling act, it is necessary for the Bureau of Mines to negotiate contracts with all owners of land, or holders of potash rights or mineral leases, within a radius of one mile of the point finally selected by the Bureau. These contracts are to be signed before drilling begins.

Canada Accumulates Gold at Ottawa

Canada is steadily accumulating gold at Ottawa, due in part to the fact that Ontario mines are now shipping to the Dominion capital instead of to New York. Receipts of crude gold bullion at the Royal Mint, Ottawa, from Ontario mines for August totaled 125,726 oz. containing 100,608 oz. refined gold, and 17,127 oz. of silver, with a total valuation of $2,090,363. Since December last, increased shipments of Ontario gold have been made to the Royal Mint, with the result that a considerable quantity of the metal is being accumulated. At the end of August, gold held by the Minister of Finance amounted to $113,375,022, of which $3,152,473 is against savings-bank deposits and $110,222,549 against notes in circulation.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Beaver Consolidated Elects New Directorate—Railway to Rouyn Nears Completion

At the annual meeting of the Beaver Consolidated Mines held in Toronto, Oct. 14, a new board of directors, headed by D. B. Hanna, Hume Cronyn, and J. B. Tyrrell, was elected. The day before the annual meeting the old board declared a devidend of 1,000,000 shares of Kirkland Lake Gold stock, to be paid to shareholders in the proportion of one share of Kirkland Lake Gold stock for each two shares of Beaver held. It is understood that the new board will contest the legality of the payment of this dividend, on the ground that it was declared after the old board knew that it could not be re-elected. At the annual meeting a report was read on the Kirkland Lake Gold Mines by M. W. Summerhayes, and the estimate of ore reserves as given by Mr. Summerhayes was very much less than has been generally anticipated. His figures showed a gross value of developed ore of a little over half a million dollars of gold in ore averaging between $13 and $14 per ton.

The September report of the Keeley Mines, of South Lorrain, shows that the average production of 125,000 oz. a month is being maintained. It also confirms the news of the recent discoveries on the 11th level. These discoveries have been of such importance that although about 125.000 oz. a month is being produced. 200,000 oz. a month has been put in sight. A further drop in the price of silver may endanger the company's dividend. Keeley costs are about 30c. an ounce; production is 1,500,000 oz. a year and the divided with the bonus calls for $480,000 a year.

The quarterly report of the Nipissing Mining Co., of Cobalt, shows that for July, August, and September the company mined ore of an estimated value of $298,787 and shipped bullion and residues from Nipissing and customs ore of an estimated value of $463,715. During the period the low-grade mill treated 19,146 tons and the high-grade plant 343 tons, while the refinery shipped 693,187 oz. of bullion. For the first nine months of the present year production was valued at $901,405, against $1,080,800 for the corresponding period of 1925. The quarterly report states that general results on the South Lorrain property have been satisfactory. In Montbray Township, Quebec, a number of diamond-drill holes have been put down on the deposit found last June, but the size and value of the orebody has not yet been determined. Though some high sections have been obtained, general results indicate a low-grade deposit.

The carload of ore recently shipped by the Canadian Lorrain contained 87,403 oz. of silver and returned $49,385 to the company. Good progress is being made on the new mill, which

it is hoped to have in operation early in December. It is understood that the company has approximately 2,000,000 oz. of milling ore developed.

On the 1,250 level of the Coniaurum mines, in Porcupine, good ore has been found in two veins. These veins lie to the south of the shaft. Sufficient work has not yet been done to determine the importance of these discoveries.

Railway to Rouyn Nearing Completion

Good progress is being made with the construction of the railway into Rouyn, and it is expected that construction will be completed according to schedule and trains will be running into Rouyn by the end of the present month. On Oct. 23, a party left for the Horne mine and expected their private car to be taken to Mile 43, less than half a mile from the Horne smelter. The party includes J. E. Perrault, Minister of Mines for Quebec; Walter Mitchell, Frank Carroll, N. A. Timmins, H. W. Chadbourne, J. Y. Murdoch, Mr. Richards, Deputy Minister of Mines for Quebec, and A. F. Brigham.

It is expected that within a few days some decision will be made as to a concentrator for the Amulet property, in Rouyn. It is believed that the first unit of 100 tons' capacity a day will be constructed. On the 150 level 30 ft. of good ore has already been opened up, and it is believed this is the extension of the same ore found on the 75-ft. level and also on the surface.

Baffin Island Explored

Some of the results of a "one man" expedition into the interior of Baffin Island have been made known with the return to Ottawa, Ontario, of J. Dewey Soper, who has been two years in the north. Mr. Soper covered more than 4,000 miles and has returned with 3,500 scientific specimens. The Department of Mines, which sent Mr. Soper into the Arctic, has expressed itself as "very well satisfied with the results attained," and adds that "many larger expeditions have been sent out for years and brought back much less scientific information and material."

Marland Oil Geologists in Alberta

A party of fourteen officials and geologists of the Marland Oil Co. arrived in the province of Alberta recently and are making preliminary arrangements for an extensive search for oil fields in that province, in connection with the partnership which has been formed with the Hudson's Bay Co.

Granby Completes Sintering Plant

The Granby Consolidated Mining, Smelting & Power Co. has completed its new sintering plant at Anyox, and the existing plant is to be remodeled and held as a reserve plant. As soon as the existing contract with the Tacoma smelter for the treatment of copper concentrate ends, all concentrate will be sintered and smelted in the blast furnace at Anyox.

Mexico City Letter

By W. L. Vail

Special Correspondent

New Mining Law Meets Opposition in National Chamber of Mines

Ganaro Garcia, president of the National Mining Chamber, has issued a statement setting forth some of the objections to the new mining laws and reasons, in his estimation, why they are extremely prejudicial to the mining interests of the country. At the outset, Mr. Garcia challenges the validity of the law for various reasons, among others that the president lacked the necessary authority to put the law in force.

One of the main objections to the new law is that it replaces the old system of extending titles to claims and replaces it with a series of concessions for exploration and development, limited to thirty years as a maximum, with power vested in the chief executive for extending the time. As the president's decision must naturally be based upon reports of various departmental subordinates, the operator, after having made large permanent investments, might find himself subject to the caprice or ignorance of an incompetent subordinate, and the entire investment would thus be imperiled. Mr. Garcia also objects to the regulations requiring deposits, the securing of concessions, and other red-tape provisions to be followed in the construction of metallurgical plants and similar structures, conditions not even imposed upon public utilities. Mr. Garcia is of the opinion that the new law works particular hardship on the prospector and small miner—a class that should be encouraged in every possible way. The present law gives the prospector a two-year exploration concession, which may be extended for a maximum period of five years. But he is required to put up a deposit, which in many cases is impossible, and he may not dispose of any of the metal extracted during this period. Under the old system, which resulted in making Mexico one of the foremost metal producers in the world, a denouncement was followed by working conditions and a title which enabled the small man to secure financial assistance. He was also permitted to dispose of his ores as extracted, which in many cases enabled him to bring the property to a point where capital might be interested while he is developing the mine.

Secretary of Commerce Defends Law

The Secretary of Commerce and Labor, on the other hand, is disposed to take issue with Mr. Garcia's objections, premises, and conclusions. He denies that the small mines represent 75 per cent of the mining industry and claims that statistics in his department show that only 2¼ per cent of the annual gold extraction of the country comes from small properties; 3½ per cent of silver; 8 per cent of the lead and 1¼ per cent of the copper. About 25 per cent of the zinc output comes from small properties, according to admissions from the secretary.

Replying to the assertion of the Mining Chamber that a number of large concerns are discontinuing operations because of the effects of the new laws, the Secretary admits the closures, but attempts to assign other reasons for cessation of work, and then proceeds to cite a number of specific cases of activity, as follows: A new concession to the Peñoles company at Temixco, Guerrero, for a cyanide and flotation plant, with a capacity of 300 tons; completion of a flotation plant at Ojuela, Durango, by the same company; another 200-ton plant by the same company (flotation) at Natavitas, Oaxaca; the operation of a 100-ton flotation plant on the Veta Grande, Zacatecas, with plans to increase facilities to 600 tons, and plans completed and approved by the department for the installation of a custom smelter at Guadalupe, Zacatecas; completion by the Pittsburg Veta Grande company of a 600-ton flotation plant in Zacatecas; and construction of a 600-ton flotation plant by the International Mining Co. near Guadalupe and Ojo Caliente, Zacatecas (the same company has invested 3,000,000 pesos in a narrow-gage railway to connect these properties); the operation of a 300-ton flotation plant by the Minerva Mining Co. in Asientos, Aguascalientes; completion of a 250-ton smelter at Campo Morado, Guerrero, by the General Development Co.; construction of new plants by the American Smelting & Refining Co. at San Juan Taviche, Oaxaca, and Ameca, state of Jalisco; and purchase since the new mining laws went into effect by the American Smelting & Refining Co. of important properties at Chontalpam, Guerrero, and Xitinga, Guerrero, which they expect to exploit on a large scale.

The Secretary then proceeds to demonstrate, by means of figures, that the increased output since the enactment of the new mining law is another proof of its efficiency.

Though it is true that the output for the first six months of the present year exceeded the output of the first six months of last year, it is argued by the opponents of the law that the effects of the new legislation are just beginning to be felt and they predict that the figures at the end of the year will be set to different music.

Other Activities in Mexico

The Xitinga property, State of Guerrero, which recently changed ownership, has, according to engineer's reports, 332,000 tons of ore on dumps averaging 110 grams of silver per ton. The property for years belonged to the Cortina family.

From the State of Mexico comes reports that work is active in the district of Temascaltepec, the Jesus Marie Co., among others, doing considerable development work. A pilot flotation plant is being built at the San Antonio mine, Zacualpam, and a 100-kilometer power line is being constructed from Zacualpam to Achotla, Guerrero.

J. N. Watson is preparing to erect a new mill on his properties at Teorepec, Guerrero. The old 10-stamp mill and concentration plant was destroyed by fire in 1913.

London Letter

By W. A. Doman
Special Correspondent

Tin Chief Market Topic in London—Silver Lowest for Several Years

London, Oct. 5.—Though it is somewhat monotonous to refer to tin so frequently, to omit doing so would be to ignore the most interesting topic of mining business at the moment. Apart from spasmodic inquiries for rubber, tin is the talk of the market. Stocks are slightly higher, at 698 tons. No unfavorable effect, however, has been produced by the excess, as there is said to be a shortage in manufacturing circles which must be supplied. After a tumble to £308 17s. 6d., the metal is quoted at £317 15s. It does not appear that this is the result of speculation; it appears to reflect a genuine demand. The market here takes its lead from the East, where the actual condition of affairs is supposed to be well known. Important firms in Malaya are buying up shares in London, and London is not slow to take the hint. This may be due to the fact that the Eastern companies can work at so cheap a rate, and that every pound on the price of the metal constitutes additional profit. Profits have hitherto been calculated on tin at about £250 per ton by the older established companies, though a much lower figure would prove profitable. It seems to be these companies that will augment the output at an early date, owing to improved methods and the installation of additional dredges.

Silver has not seen a strong market since the report of the Indian Currency Commission, and China has been a persistent seller. The price is now 26⅜d. per ounce, the lowest for many years. Producing companies naturally are hit, Burma Corporation, Santa Gertrudis, and Mining Corporation of Canada particularly. Optimists who have experienced a drop in years gone by are hopeful that the East will again turn round and invest. With the changed condition of things in India hoarding on so vast a scale as hitherto is scarcely likely to be resumed. The marriage market naturally is a factor, but not an every-day one.

With the appearance of the annual report of the Johannesburg Consolidated Investment Co., platinum shares have received another stimulus. Solly Joel and his engineers do not as a rule "talk through their hat," as the phrase goes, and the experts write in a distinctly hopeful vein. "Johnnies" has acquired a controlling interest in Potgietersrust Platinum (Transvaal), and the directors "are satisfied that there will be established in South Africa a permanent platinum-mining industry of great value, and the Potgietersrust Platinum, Ltd., promises to be the most important producer. It controls large areas of ground, and the deposits are wide and of good grade." Following so closely on the Transvaal Platinum, Ltd., fiasco this is welcome news, and has heartened shareholders who became interested in platinum ventures at prices far in excess of those at present ruling.

The Anglo-American Corporation, which had been brought into the South African courts by people connected with Tanganyika Diamonds, Ltd., and charged with withholding vital information, has won the case and, so to say, left the court without a stain on its character.

Dr. Malcolm Maclaren, who has been visiting the Transvaal and Rhodesia on behalf of the Consolidated Goldfields, has returned. At present he has only reported to his principals.

Frank B. Powell, who has spent some months in Nigeria on behalf of the Barrier & General Trust, investigating tin properties, has also returned. He has located various areas that he considers well worth developing, and he speaks well of a new company—the Naraguta Karama.

Depression in Spanish Iron Mining

The iron-mining industry at Bilboa, Spain, is suffering the greatest depression of its history, according to the U. S. Department of Commerce. Exports of iron ore in August totaled 13,000 metric tons and those for September 36,000 tons, a marked increase; but these shipments continue far below the 1925 figures, in September of which year 123,000 tons was sent abroad. The principal purchaser of the Spanish ore was the Netherlands. British purchases were practically nil. This acute situation is offset somewhat by the steady prosperity of the Spanish metallurgical plants, which are operating full time. There is marked competition between France and Germany for the Spanish markets for a number of commodities, including steel products. British steel exports to Spain are virtually at a standstill.

Investors in Salvador Silver Charge Conspiracy

An action arising out of the collapse of El Salvador Silver Mines Co., which passed into the hands of a receiver in 1922, was advanced on Oct. 16, when the judicial authority refused to dismiss a complaint charging conspiracy to defraud investors, made by Thomas A. Howell of Glen Head, L. I., and James H. Post of Brookhaven, both men of wealth and leaders in the sugar industry, together with four associates.

In his complaint Mr. Howell tells of a series of "false and fictitious" dealings on the part of Henry R. Hoyt and Mr. Frothingham, which induced him and the other plaintiffs to purchase stock. Mr. Howell and his associates seek to recover $464,000.

First Oil Well in Saskatchewan

Oil of 32 gravity, with an estimated production of 30 to 50 bbl. a day, has been struck by the Unity Valley Oil Co., Unity, Sask., Canada. The well was first spudded on June 16 and is working in a 12-in. hole. Drilling operations are being resumed in an effort to reach secondary sands. This is the first oil well to be brought in in Saskatchewan.

Johannesburg Letter

By John Watson
Special Correspondent

New Gold Reef Twenty-five Miles East of Rustenburg; Company Formed

Johannesburg, Sept. 7.—The following crushing results for the month of August, 1926, from fourteen leading Rand gold mines, have recently been published. The mines are arranged in order of profits earned:

	Tons Crushed	Value or Revenue £	Costs per Ton s.	Costs per Ton d.	Estimated Profit £
Government Areas	200,000	386,758	16	3.7	225,162
New Modder	132,000	288,563	17	11.5	170,057
Crown Mines	224,000	298,372	18	6.0	91,136
Modder Deep	44,200	99,527	15	4.0	65,604
Springs	66,500	124,684	19	5.2	60,063
Brakpan	85,100	136,170	19	2.2	54,528
New State Areas	76,000	131,669	20	4.7	54,485
Van Ryn Deep	70,300	106,970	16	3.1	50,651
Geduld	83,000	120,201	17	2.0	48,951
Modder B	68,000	109,871	18	1.1	48,352
Randfontein Estate	195,000	207,607	18	0.3	34,156
West Springs	51,300	79,522	17	11.7	33 421
City Deep	101,000	146,988	23	1.1	30,379
Robinson Deep	76,100	.....	17	11.1	29,502

The Moorcroft Reef

At the meeting of the Geological Society of South Africa, held in Johannesburg, on Aug. 30, a new gold discovery on the farm Waaikraal, No. 205, 25 miles northeast of Rustenburg, was described by Dr. Percy A. Wagner. Gold, in fairly coarse grains, had been known to occur, in the surface soil on this farm, for a long time; but last year W. M. Edwards traced the gold to its source, which he named the Moorcroft Reef. This has been exposed over a length of strike of 308 ft. Dr. Wagner described the new occurrence as unique and promising. It takes the form of an irregular inclined sill of a dark-colored igneous rock which, wherever opened, has been found to contain gold in notable quantities. Samples taken by J. E. Vaughan, Inspector of Mines, and V. Grindley Ferris have been assayed and gave results, from various parts, varying from 0.8 dwt. up to 6 oz. 1 dwt. per short ton.

A company has been registered to take over prospecting contracts over portions of the farms Waaikraal, No. 205, and Beestekraal, No. 503. This company is formed with a nominal capital of £35,000 in 5s. shares, of which 62.000 are vendor shares and the remainder have been fully subscribed.

On the Johannesburg Stock Exchange during the last week, the share market has been fairly active. London has bought and sold, here, on a considerable scale. The outstanding feature of the week has again been Sub-Nigels, which have been bought and sold with considerable fluctuations. Their closing sale price on Saturday was 55s. 7½d., only 1½d. higher than the previous week. At one time during the week they reached 57s. 9d.; at another they fell to 53s. 3d. Van Ryn Deeps improved during the week from 47s. to 50s., as the result of London buying. Potgietersrust platinums were heavily bought and have risen from 8s. 5d. to 9s. 4d.

People You Should Know About

R. E. Hore, editor of the *Canadian Mining Journal,* has been in New York.

Augustus Locke, mining geologist of San Francisco, was in New York recently.

Senator Key Pittman, father of the Pittman Silver bill, is touring Montana.

Bradley Stoughton was recently in Butte, Mont., as an expert witness in the Carson case.

H. C. Wilmot has been in New Mexico on examination work. He expects to return to Los Angeles by Oct. 25.

J. Ross Corbin, of the Pennsylvania Geological Survey, is on temporary leave of absence to do professional work in Canada.

William E. Colby, mining lawyer of San Francisco, is in Butte, Mont., as attorney in a mining lawsuit for the Clark interests.

W. V. De Camp, general superintendent for the United Verde Copper Co. in Arizona, has been in New York, on company business.

Donald C. Barton, chief geologist for the Rycade Oil Corporation, has returned to his Houston headquarters from a trip to New York.

E. F. Burchard, of the U. S. Geological Survey, was in San Francisco recently. Mr. Burchard is collecting information on iron ore deposits.

W. A. Brooks is now mine manager of the Berta Mining Co., with headquarters at Chihuahua, Mexico.

B. B. Thayer, vice-president of the Anaconda Copper Mining Co., is expected in Montana in a few days to inspect the operations of the company.

Professor George P. Schubert, of the Michigan College of Mines, is making an extended trip to the mines, mills and smelters in Colorado, Utah and Montana.

W. Gemmill, general manager of the South African Chamber of Mines, recently returned to Johannesburg from a tour of the Mozambique native recruiting stations.

C. H. Mathews has been designated to have charge of subjects relating to mining engineering in the industrial engineering department of the Westinghouse Manufacturing Co.

E. B. Dawson is now connected with the industrial engineering department of the Westinghouse Manufacturing Co. as consultant on electrochemical and electrometallurgical subjects.

L. S. Cates, vice-president and general manager of the Utah Copper Co., has arrived in Salt Lake after a two months' vacation trip through England, France, Holland, Germany and Italy.

Dr. A. L. Hall, assistant director of the Geological Survey of South Africa, has been selected by the Minister of Mines and Industries to give evidence before the Base Metals Commission in London.

E. J. Atchison, vice-president of the Southwestern Engineering Corporation, of Los Angeles, has returned from a trip to the Panhandle oil fields of Texas and the lead-zinc mining district of Missouri.

Hal. M. Lewers, for many years chief metallurgist for the Tonopah Belmont Development Co. at Tonopah, Nev., has been transferred to the company's new property at Wickenburg, Ariz., where he will be mill superintendent.

Governor J. E. Erickson, of Montana, has appointed Mrs. Cornelius F. Kelley, wife of the president of the Anaconda Copper Mining Co., to represent Montana officially in welcoming to the United States Queen Marie of Roumania. Mrs. Kelley is in New York.

M. H. Guise

M. H. Guise recently returned to his home in Seattle, after a summer prospecting in the White River copper country, in the interior of Alaska. He reports that country as much in need of better transportation, dog teams and pack horses now being the only means of crossing the glaciers. Mr. Guise is the young mining man who last summer ran out of supplies while prospecting in the Arctic mountains and then, failing to find any game whatever, built a crude boat of willows and grass and his clothing and ran the swift waters of the Sneenjek 200 or 300 miles down to the Yukon.

C. D. Pryor, engineer for John Taylor & Sons, Ltd., of London, will soon arrive in Canada to make an examination of the property of the Central Manitoba Mines, Ltd., in which the Taylor firm is heavily interested, to ascertain the most suitable site for a mill.

W. C. Mendenhall, of the Geologic Branch of the U. S. Geological Survey, arrived in Honolulu on Oct. 8 on his way to the Pan Pacific Science Congress, which opens in Tokyo Oct. 27. **L. F. Noble, H. E. Gregory, T. W. Vaughan,** and **M. N. Fenneman** will also attend the Congress.

R. W. Handley, until recently superintendent of the flotation mill of the International Smelting Co. at Tooele, Utah, has accepted a position at the new Panda concentrator of the Union Minière du Haut-Katanga in the Belgian Congo. Mr. Handley is taking his family with him and expects to remain in Africa on professional business for three years.

S. Power Warren, consulting engineer, and **D. C. Derringer,** mill superintendent for the Mazapil Copper Co., of Mexico, spent several days in Utah recently visiting mills. They studied the operations at the Utah-Apex mill, the International S. & R. Co., at Tooele, the Combined Metals Co. mill at Bauer and the new mill of the U. S. S. M. & R. Co., at Midvale.

Albert Burch, of San Francisco, **Professor A. W. Lawson,** of Berkeley, Calif., **W. J. Mead, F. W. Ransome,** of Tucson, Ariz., and **William A. Simkins,** of San Francisco, are in Butte as expert witnesses in behalf of the Clark interests in a pending apex suit. On the Anaconda Copper Mining Co.'s side are **W. Lindgren,** of Boston, Mass., **W. H. Wiley, Alan M. Bateman,** New Haven, Conn., **Sam Barker,** and **Richard Hunt.**

J. Dewey Soper, who was commissioned by the Canadian Department of Mines to expore the interior of Baffin Island previously unexplored, has returned after having been for two years engaged in the work, in the course of which he covered a distance of over 4,000 miles. He brought back sixty-six cases of geological and ethnological specimens, and many photographs and other material and data which are regarded by the department of great scientific importance.

O. E. Keough, who has been at the International Smelting Co.'s concentrator at Tooele, Utah, has been appointed superintendent of the selective flotation mill that the International company has equipped at Rico, Colo. Mr. Keough at Tooele was assistant to **Walter C. Page,** superintendent of concentration, and was in charge of the concentration testing laboratory there. **W. A. Kaattari,** also from the Tooele plant, has been appointed metallurgist at the Rico mill.

Dorsey A. Lyon, supervisor of experiment stations for the U. S. Bureau of Mines, has returned from Michigan, where he conferred with **W. R. Crane** as to the studies which he will make in the copper region. Dr. Crane will have his offices at the Michigan School of Mines, but he expects to spend most of his time in the field gathering data for a study of subsidence and drainage. This is to be a study extending over two or three years and will be somewhat similar to that conducted by Dr. Crane in Alabama mines.

Obituary

Joseph Myers, president of the Bingo Gold Mines, Ltd., in northern Manitoba, died at the General Hospital, at Winnipeg on Oct. 11, at the age of fifty-two. He had come to Winnipeg on business when he was suddenly taken ill. Mr. Myers represented several British financial interests in the Manitoba mining field, principally in connection with the Bingo. He was an unsuccessful candidate for Parliament in the Conservative interest at the recent Dominion election.

Societies, Addresses, and Reports

Canadian and American Mining Engineers Meet at Spokane

By George J. Young
Associate Editor

AN INTERNATIONAL GATHERING of mining engineers was held at Spokane on Oct. 13 and 14, 1926, being a joint meeting of the Canadian Institute and the American Institute of Mining and Metallurgical Engineers of the Northwest—Washington, Oregon, Idaho, Montana, and British Columbia—with a scattering of members of both Institutes from more distant localities. All mining associations of the Northwest co-operated to make the meeting representative of the mining industries of the region. Lewis Stockett, president of the Canadian Institute, and George C. Mackenzie, secretary, were present, and Philip N. Moore of St. Louis, past president of the American Institute, represented Samuel A. Taylor, president of the American Institute. Important mining companies sent representatives.

Philip N. Moore Represented A.I.M.E.

Meetings were held in the attractive Davenport Hotel. Welcoming addresses were extended by Charles A. Fleming, Mayor of Spokane; John F. Davies, president of the Spokane Chamber of Commerce; and E. R. Hannibal, of the associated engineers of Spokane. Philip N. Moore and Lewis Stockett responded, as did also Charles A. Banks, chairman of the British Columbia Division of the Canadian Institute, and C. E. Newton, of the Columbia section. At the noon luncheon Philip N. Moore delivered an address on the engineer's opportunity. He took as his text certain concepts of the engineer that appeared in David Papillon's work on Fortifications, a book that appeared in 1645. This old book revealed the fact that human nature of long ago did not greatly differ from what it is at present and that the quaint conception of the requirements of an engineer and his difficulties likewise have a present bearing.

Technical papers were presented at the afternoon session. J. D. Galloway, Provincial Mineralogist of British Columbia, discussed "The Examining Engineer and the Mineral Industry." Louis Stockett presided. Mr. Galloway may be forgiven for presenting a concise résumé of the mining opportunities of British Columbia, for there are many in that province of Canada. However, he quickly launched into his subject and said:

"Increases in our production of lode minerals in the future will come from:

"1. Expansion of existing mines.

"2. Discovery and development of new orebodies.

"3. Development to the productive stage of many of our mineral claims at present lying dormant.

"One of our great mineral assets at the present time lies in the thousands of undeveloped mineral claims located all over the province. Of course, many of these claims are of no value either now or in the future, but some of them undoubtedly are potential mines. It is in recognizing the value of some of these properties, and recommending them for development, that the important work of the examining engineer to the mining industry of the province is to be found.

"The examining engineer is the link between the prospector and the mining company, between the seller and the buyer. We are all agreed that only through the work of the prospector and the examining engineer can the output of minerals and metals be maintained; the mining operator and the ore-treatment expert are very useful and necessary, but a continual supply of raw material is the first essential.

"It is, therefore, important to the industry as a whole that our examining engineers should be of a high standard. They should possess, in some measure, the qualifications both of the geologist and of the mining operator. They must have a first-class knowledge of geology and mineralogy in order critically to analyse the criteria of an orebody, and they also require the operator's experience which will enable them to consider the various factors and arrive at a proper estimate of costs, of working conditions, and other factors.

"The examining engineer is called upon to examine:

"1. Raw prospects.

"2. Prospects which have been located for years, but on which only a small amount of work has been done.

"3. Properties which have been partially developed and abandoned for short or long periods.

"4. Properties which were once productive, but which were closed down owing to the apparent exhaustion of the orebodies.

"The work of examination is perhaps easier with No. 2 than with any of the others. In many cases, No. 1 properties cannot be 'sized up' without doing the preliminary work that has already been carried out on the No. 2 class. Properties coming under the No. 3 classification can be intelligently appraised if sufficient time is given, but old workings must be very carefully examined in order to get necessary information. The fourth class, comprising apparently exhausted mines, presents a difficult problem, since the evidence desired is often destroyed by the work of production.

"As a rule, when a mineral property is examined by an engineer, fairly complete information is obtained about the character and size of the deposit, the nature of the formation in which it occurs, transportation facilities, working conditions, etc., and some sampling is done. I would suggest that, in addition, the following points should be studied, although in many instances the requisite data are not available:

"1. Influences determining oreshoots.

"2. Influence of faulting.

"3. Influence on ore of changes in wall rock.

"4. Influence of structural geological features.

"5. Character of surface mineralization and inferences that may be drawn from this.

"6. Experience to be gained from surrounding properties.

"7. Possibility of obtaining much more information with comparatively little development.

"8. Possibility of working property for high-grade shoots, or whole deposit for milling.

"9. Selective sampling to determine in which mineral or minerals the important values are contained.

"Evidence to determine many of the above points is often lacking, particularly in raw prospects. In partially developed and dormant properties, very careful investigation along these lines is often useful and informative.

Duplication of Effort of Examining Engineers

"During the last three years many examining engineers have been looking for mineral properties in British Columbia. It is noticeable that the same property is very often examined by several engineers before it is recommended by one of them. The time has probably arrived when more prospects will be taken up than in the past. At one time, if a property did not show a deposit of commercial size at the outcrop it was not considered worth development, but now the requirements are not quite so rigid. It often happens that a prospect showing some mineralization and favorable possibilities, from the geological standpoint, after being examined and rejected by a few engineers, is finally recommended for development by one who is a little more courageous than the others. We may expect, therefore, that, as time goes on, many of our mineral properties which have lain dormant for years will be tested by someone.

"Many mining companies now are prepared to examine and develop raw prospects. Engineers scouting for such companies are not expected to pick a potential mine on every favorable recommendation; it is recognized that, with many prospects, some development work at least is necessary before any definite conclusion regarding the property can be arrived at. As a rule, several such partially developed prospects will be examined before one profitable mine is discovered. The larger mining companies operate on this basis, and their engineers usually recognize this principle."

In the ensuing discussion of Mr. Galloway's paper, Philip N. Moore stated that he cordially agreed with the speaker but pointed out that courage is an essential requirement of the examining engineer. The property in question should be given a fair chance, and he should not take the job unless he has the courage to risk his reputation upon his conclusions. F. A. Thomson, of the University of Idaho, quoted F. W. Bradley as having stated at one time that "we need to be patient with some of these prospects." I think, said Mr. Thomson, that we might all profit by

Engineers and Their Friends at the International Meeting

this point of view. Continuing, Mr. Thomson pointed out the real difficulty caused by some prospectors holding out for ridiculous prices and the frequent inability of the engineer to make reasonable price arrangements, thereby resulting in the turning down of otherwise good properties. Other speakers discussed the misinterpretation of reports which are frequently made too conclusive by the reader and do not by any means always condemn a property. The discussion indicated the trend of sympathetic feeling toward a recognition of the probabilities of the unexplored prospect.

L. K. Armstrong, the energetic secretary of the Columbia section, precipitated a discussion of the economics of power production by his statistical references to the potential coal resources of Washington. Lewis Stockett brought out the point that power produced by hydro-electric plants is not always cheaper than power produced by steam plants from coal fuel. As at other points in the West, the discussion indicated that the relative economy of power-producing methods is being better understood and a greater appreciation of the possibilities of modern steam power plants is prevalent.

Joseph Daniels, of the University of Washington, and chairman of the North Pacific Section of the Institute, discussed the mineral resources of Washington, giving a keen analysis of the situation and showing potentialities in water-power and coal. He said that the State of Washington is planning the development of manufacturing within its borders that will supplement the wealth now derived from lumber, horticulture, fishing, agriculture, and mining. Raw materials are available in the ceramic field and products for structural purposes are abundant. His logical summation is an important contribution to the industrial economic survey of the state.

Mining in warfare, a paper by Major A. W. Davis, of Vancouver, B. C., was read by C. A. Banks, who was also an engineer on the front in the World War. Mr. Banks discussed various angles of shaft sinking and tunneling in clay under the difficult conditions prevailing during the war. The importance of the miner and his art was told in an interesting way. J. G. McMillan of Ontario, also one of the mining engineers who served during the war, regaled the audience with his personal experiences in tunneling no-man's land.

Climbing Mount Logan

The climax of the day was the thrilling account of the ascent of Mount Logan by Colonel W. W. Foster. Mount Logan is near Mount St. Elias, in a salient of the international boundary on the Canadian side. Its altitude is about 20,000 ft. and it is the highest mountain in Canada and also the highest in the British Empire, other than the mountains of India. Professor Russell, of the U. S. Geological Survey, some thirty-six years ago described the region and the mountain; but until Colonel Foster's party succeeded it was never scaled. Colonel Foster stated that a reconnaissance party studied routes in 1924, and in the winter of 1924 supplies were brought in through the Chitina Valley by dog teams and cached at a base camp. The party started in May, 1925, and after great hardship succeeded in making the ascent. A series of remarkable pictures made more vivid the details of this exploit.

On Thursday Philip N. Moore presided at the technical meetings. E. H. Parker, efficiency engineer for the Elm Orlu Mining Co., presented a paper on the "Development of the Contract System at the Elm Orlu Mine." Mr. Parker stated that in order promptly to introduce a system of compensation involving performance, the factors developed at the neighboring Butte & Superior mine and the classifications originated by the Phelps Dodge Corporation in the Bisbee district were adopted and modified by preliminary studies in certain stopes in the mine. He said: "There were at that time three wage incentive systems in use in the mines of Butte. Payments in the majority of mines was by the cubic foot of ground broken and cubic foot of stope volume timbered. The rates varied with the width of the stope, the hardness of the ground, and the special conditions encountered. The rates were set by the foreman and based on his judgment. One company was using the bonus system based on standardized time allowance for each individual operation, and another company was paying unit prices; for example, ground broken by the cubic foot, timber by the set stood, raising by the floor, and other details. In every case earnings were figured and paid weekly. Of these plans two were piece-work with a minimum guarantee and the third was bonus. The term contract is a misnomer when used in reference to Butte [illegible] plans, because day's pay [illegible] paid the workman and no true [illegible]s."

Respecting stope prices, Mr. Parker stated that two men spent six weeks making individual studies of the stopes selected and then made a proposed scale of prices based on their time-studies. This scale was then adjusted, which adjustment was made to correspond to an expected increase in efficiency. Development rates were based on Phelps Dodge specifications after making time studies of the drilling speeds in the various classes of rock in the Elm Orlu mine. Mr. Parker added: "A sliding scale based upon classification loses its value unless applied when the change occurs. To insure that the workmen are notified of these changes in classification and price, three men are employed to check the contracts. Each man has about forty contracts during the month. The checkers spend their mornings in the mine, recording the work done in the stopes, closing or starting contracts, and making necessary reclassifications. Afternoons are spent in the office posting the time from the shift-boss distribution sheets, calculating the contract efficiency sheets and in figuring completed contracts for payment."

Contract bonuses are paid only once each month, which system has proved to

Meeting Held Last Week in Spokane, Washington

be advantageous in reducing labor turnover. Respecting disadvantages of contract systems, Mr. Parker said: "The Elm Orlu system, in common with other plans in use in Butte, has its disadvantages. Labor conditions during the war and immediately thereafter forced high rates on the district. The result has been that the best contractors will consistently make larger earnings than the shift boss over them. This condition weakens the shift bosses' authority over the men, and the best contractors have no desire to become bosses. This does not mean to imply that the best contractors would always make the best bosses. Another disadvantage is that the men working on day's pay 'soldier' on the job unless closely supervised. In spite of these faults the co[illegible] system has justified itself."

Many questions about the system and great interest was manifest among the mine managers who were present.

C. E. Cairns, geologist of the Canadian Geological Survey, presented the next paper, a résumé of the history, development, and geological conditions in the Slocan district of British Columbia. He said: "Properties are now valued for their zinc as well as for lead and silver. It is a common sight to see old dumps being worked for the recovery of their zinc content. But while zinc is becoming an important factor, lead and silver will still continue to be the most important metals in the district. For a long time to come lead returns will exceed those of zinc, although it is possible that zinc returns will be greater than those of silver."

"Theory and Application of Stratification in Ore Dressing" was the subject of A. W. Fahrenwald, of the U. S. Bureau of Mines. Mr. Fahrenwald discussed the principles involved in hindered settling classification as a preliminary operation to jigging and tabling. Byron M. Bird, also of the Bureau of Mines, discussed the principles described by Mr. Fahrenwald in relation to their application to coal cleaning and told of some of his experiences in observing ore-dressing practice. W. L. Zeigler, mill superintendent of the Hecla Mining Co., corroborated the importance of proper classification of table feed and stated that by this practice table tailings at his mill had been reduced to from 0.4 to 0.5 per cent lead.

Electrical Prospecting Prevents Waste and Ill-Advised Development

One of the interesting papers of the session concerned electrical prospecting at the Britannia mine by James J. Moore, Jr., and Frank Ebbutt, respectively mine superintendent and chief geologist. Mr. Moore, who presented the paper, said:

"The location of mineralized areas will continue to be the task of the prospector and geologist, but when outcrops are few and far between and the question arises where to locate a shaft or tunnel, or, from the investors' standpoint, how to spend money most effectively, electrical prospecting is the physician to call in for consultation. Electrical prospecting will furnish an outline of the limits of mineralization, and will show the engineer where to sink the shaft, or where to do the most effective diamond drilling.

"Broadly speaking, the more electrical prospecting that is done, the fewer cases will there be of ill-advised development or of wasted money. Of course, in rugged country where outcrops are plentiful and the mineral is exposed, there is no field for electrical prospecting. On the other hand, it can be most advantageously employed in areas covered by varying depths of overburden of boulder clay, blankets of moss and marsh, and in heavily timbered country, where the prospector and geologist are unable to guide the engineer.

"Two applications of the potential method have been used successfully at Britannia and in other localities: (a) by reading, on a sensitive galvanometer, the difference in potential between fixed points; and (b) by studying surfaces of equal potential. In either case the orebody may be easily outlined, though in this respect the second method perhaps yields the more definite results, as the points of equal potential are readily detected in the field and, when plotted on a surface plan, they are easily interpreted.

"The ore occurs in a series of parallel lodes, or veins, of varying widths and separated by variable thicknesses of low-grade or barren schist. The ore is composed of massive chalcopyrite and pyrite, the proportion of the two varying from place to place.

"These geological and mineralogical conditions were ideal for the employment of one or both of the potential methods. It was necessary merely to run lines at right angles to the shear zone from one side to the other, and plot the points of equal potential, or the difference in potential at various points on each line."

Respecting the outcome of the Britannia work, Mr. Moore stated that by the use of the equal potential method an orebody was indicated and in the course of exploration at a depth of 200 ft., it was encountered in the position indicated. He concluded his paper with an interesting description of the Clayton Metalophone, an instrument which demonstrated its ability to indicate stray pieces of metal but which apparently failed to show the presence of orebodies.

G. C. Mackenzie closed the meeting with a brief presentation of the constructive work now being done by the Canadian Institute of Mining and Metallurgy for the junior members of the Institute. Every effort possible is being made by the members to take care of these younger men and to encourage them in the task of thoroughly preparing themselves for a career as mining engineers.

On Friday, a party composed of members of both institutes left for a trip to Kimberley, B. C., at which point the mining and milling operations of the Consolidated Mining & Smelting Co. of Canada were studied. An account will appear in next week's *Mining Journal.*

Future of Shale Oil and Tin Discussed by M. & M. Society

Exhaustion of World's Tin Resources Approaches; Oil-Shale Industry on Threshold of Great Development, Say Speakers

By A. B. Parsons
Assistant Editor

TWO decidedly different pictures—one of tin, and the other of oil shale—were drawn at the regular meeting of the New York Section of the Mining and Metallurgical Society of America, on Oct. 14.

G. Temple Bridgman, mining engineer for Guggenheim Brothers, foresees a production of tin at about the present rate for the next ten years, with acute price fluctuations synchronizing with general prosperity; and "a constant, fairly rapid, and virtually complete approach to exhaustion" of the world's tin resources thereafter, with no limit to the levels to which prices may rise. Guy C. Riddell, consulting engineer, views the production of oil shale as a profitable enterprise, under favorable conditions, today; and predicts that within, say twelve years a huge industry, involving the mining of upwards of 350,000,000 tons of shale and the production of 225,000,000 bbl. of oil per annum, will develop.

In California, according to Mr. Riddell, a plant with a capacity of 160 tons per day is producing oil for $1.25 per barrel. This is now being enlarged to 1,000-ton capacity, on which basis a cost of $0.75 or even lower is expected. Although the "ore" is not really shale, but a diatomite impregnated with bitumen, shale has been tested in the plant, and the recovery and costs have been comparable. This is the only commercial operation of any size in the United States. However, several of the leading petroleum companies are actively engaged in the development of the industry, and progress should be rapid.

Shale Oil at $1 per Barrel

In Mr. Riddell's opinion the notion that the shale-oil industry must await high-priced oil is not warranted. The average cost of American "well" oil for a 2½-year period is estimated at $2.17 per barrel; Mr. Riddell thinks $1 a fair estimate for the cost of shale-oil. He outlined the processes used for recovery. What he calls the "internal-combustion" principle, conducted after the fashion of a Dwight-Lloyd roast, gives the most promising results. So-called fractional distillation and externally fired retorting are not likely to be used extensively.

The available tonnage in the United States has been estimated at not less than 400,000,000,000 tons, and Mr. Riddell is not hesitant about doubling this figure of almost astronomical size. The problem is one of economical manufacturing on a large scale in an unpopulated region. Steam-shovel mining and subsequent crushing and treatment offer big opportunity to the mining engineer. Many of the deposits, of course, are so situated that underground methods of mining will be necessary, probably patterned after coal-mining operations.

The difference between a shale field and a well field is one of advance. Nature has gone farther in the well-oil field; she has performed some of the processes that in the shale field remain for men to do. Mr. Riddell's talk stirred up so much interest that H. K. Masters, chairman of the section, tentatively promised an entire evening to be devoted to the subject at some future date, before directing attention to the second subject of the evening: Tin.

Mr. Bridgman confessed that his knowledge of the subject was a bit one-sided, in that he was not particularly familiar with the consumption branch of the tin industry. His hearers certainly agreed, however, that he was thoroughly posted on the world's tin mines and mining regions.

The future must be viewed, thinks Mr. Bridgman, in two periods: The next ten years or thereabouts; and the ensuing era. During the first ten years production should continue at about the present rate, 150,000 tons per year. Enough new mines will be opened to offset the loss of those that become exhausted. The price is likely to fluctuate widely, but this will not affect output seriously. For one thing, the average cost of production is about 35c. so that a large decline from the present price of 70c. can be made before many mines will be closed down as unprofitable. In the Malay Peninsula the workers are imported Chinese coolies, and producers cannot afford to curtail production for fear of losing their men. This is one of a number of factors that make great reduction in output for ten years unlikely.

On the other hand, a large increase in the rate of output is also unlikely. Billiton and Banka, producers of 23 per cent of the world supply, are under the direct control of the Dutch Government. The government sees ten years' operation at the present rate and has no inclination to increase output. The price outlook also dictates against expansion of operations. The possibility of a collapse of the price for a year or two because of widespread depression argues against increasing the capital investment. Then the probability that the average value of the ore from 1931 to 1935 will be greater than the average for the period from 1926 to 1930 makes it bad business to hurry production now.

Mr. Bridgman sees as the big factor in the price of tin, not cost of production, but the insistent demand; and coupled with this, speculation in the market. The cost of the tin involved in the manufacture of any article is not an important factor in its cost; accordingly in times of general prosperity, tin will be used with little or no regard to cost. But if there comes a period of hard times, consumption will fall off and with slight change in production the price is likely to take a bad tumble for a time.

The wolf cry of early exhaustion of the world's resources of various metals has been heard before—and it never yet has come. However, Mr. Bridgman was bold enough to venture the opinion that the tin supply would decline rapidly after the next decade. He reviewed the world's tin areas, (a) Dutch East Indies, Siam, Malay, Burma, 60 per cent; (b) China, 5 per cent; (c) Nigeria, 4 per cent; (d) Bolivia, 23 per cent; and (e) Australia, Cornwall, and miscellaneous, 8 per cent. He showed that 95 per cent of the production from the first region is from placer deposits; that the areas are accessible and the reserves fairly well known. In Bolivia, where the tin comes from rich narrow veins, a big increase in output has been talked about for next year. But no new deposits of importance have been found in ten years, and from his knowledge of conditions Mr. Bridgman is inclined to doubt any great expansion. Here, however, the life of the mines probably will be long and production at the present rate should continue "indefinitely."

There are tin possibilities in Indo-China and in Africa, among other places on the globe, but exploration to date has not been particularly encouraging, and large tin-bearing areas are not easy to conceal. His conclusion is that, though the tin mining industry may continue active and prosperous for a long time, it will be because of high selling prices; and that in terms of metallic yield the industry will decline rapidly after 1936 or thereabouts.

Charles S. Trench, who has lived with the tin market in New York for thirty years, and who probably is less in the dark about a complicated and obscure situation than any other American, was a guest of the section. He asked a few trenchant questions, and pointed out to the technical gentlemen a few problems that challenge their best effort.

Coal and Steel Topics Before A.I.M.E. at Pittsburgh

A large attendance, principally of local men, and an entertainment that will long be remembered, good papers, and instructive visits characterized the meeting of the American Institute of Mining and Metallurgical Engineers at Pittsburgh, Oct. 5-9, including in that period several round-table conferences on coal and steel, held by those who had come to attend the main sessions. An endowment fund of $1,000,000 for the support of the work of the A.I.M.E. is to be sought by that organization, according to Charles F. Rand, its treasurer, who made a brief address toward the close of the general meeting of the Institute in the Carnegie Music Hall, on Oct. 6. At this meeting Graham Bright, consulting engineer, presided. S. A. Taylor, president of the Institute, delivered an address on the development of mechanical operation in the mines of the Pittsburgh district. J. S. Unger, of the Carnegie Steel Co., discussed the development of the technique of the steel industry, saying that today the presence of even sulphur in small percentage in steel was beginning to be recognized as not harmful. The addition of copper to steel had greatly increased the life of the latter. Houses he predicted would soon be quite generally built of steel.

Recent Technical Publications

Reviews, Abstracts, and References

Yearly Business Operations Since 1790

Business Annals. By Willard L. Thorp and Wesley C. Mitchell of the National Bureau of Economic Research, Inc., New York. Price $4.

No phase of business activities possesses more real interest to the executive and student of industrial operations than the study of the recurring "ups" and "downs" of business and industry, or what has commonly come to be known as the "business cycle." Its probable duration, and degree of prosperity and depression, if they could be foretold, would take much of the uncertainty out of business operations as they exist today. The comprehensive study of this subject, therefore, which has been made by Willard L. Thorp and just released by the National Bureau of Economic Research under the title "Business Annals" is a most welcome and interesting contribution to the science of modern business.

"Business Annals" is an attempt to summarize and depict business conditions in seventeen countries as they appeared to intelligent and expert observers. The tables and yearly business and economic analyses run back through a considerable period, those pertaining to the United States and England extending back yearly to 1790. Each year of this extended period is summarized as to economic conditions,—industrial, commercial, labor, money, security, foreign exchange, agricultural production and prices,—and is also reviewed as to various non-economic phenomena which may have exerted an influence upon the general conditions of business.

This record of business conditions has been made especially valuable and attractive to the general reader by the inclusion of a chapter written by Wesley C. Mitchell explaining and interpreting the basic record in considerable detail. The cyclical character of business fluctuation and the duration of these business cycles is thoroughly discussed. Counting the business cycles as the intervals between recessions, the author notes 32 business cycles in the United States in 127 years, which yields an average length of not quite 4 years. The commonest length is about three years and two-thirds of the cases fall within the limits of three to four years. There is no indication that the average duration of business cycles is changing. The interesting fact is brought out that American business cycles have a shorter average duration than those of any other country studied.

For those interested in the study of business and industrial trends, in the probable extent of the present period of prosperity, and the period of decreased industrial activity which must follow, this book will prove of large interest. It is a valuable contribution to the science of business and industrial management and administration.

R. M. DAVIS.

Mathematics for Engineers. By Raymond W. Dull. McGraw-Hill Book Co., New York. Price $5.

Engineers have more practical use for mathematics than do any of the other professions, and yet there are few books of reference on this subject. Usually the engineer must turn to his college textbook, which was written with a different purpose in mind than to afford information in the broad field of mathematics to the practicing engineer. Or he can turn to Peele, Kent, or to some of the other engineering handbooks for tabloid references. The book under review will be of much more practical benefit than any of these. All the various common branches of mathematics are covered: arithmetic, algebra, trigonometry, geometry, and calculus, with special treatment of certain subjects such as absolute and relative errors, the slide rule, and the proportional divider. The treatment is of practical application throughout, from the short-cuts for addition, subtraction, and multiplication in the first few pages to integration at the end. The work is not only a good reference book on the subject, but is worth while for browsing purposes in an idle hour, for those who have liked mathematics at school but who have forgotten most of what they had learned.

Geological Map of Part of Chile

Mr. Homer C. Neal, Casilla 3127, Santiago, Chile, has compiled from written and unwritten sources a geological map of a large part of Chile, lying between the 22d and 38th meridians. Those who are interested in this map can doubtless obtain a blueprint by writing to Mr. Neal. In connection with the map Mr. Neal writes:

"The map of the surface geology of Chile is intended as a preliminary map which it is earnestly hoped will be completed and corrected by the sending of available data to the compiler. The present map is a compilation of everything that has been obtainable on the subject, tied together by the compiler, who has been over a large part of the ground in person, although his trips have always been made hurriedly with other objects in view and he has made no detailed study of any area."

Nova Scotia Gold—The July *Bulletin* of the Canadian Institute of Mining and Metallurgy (604 Drummond Building, Montreal; price $1) contains a 66-page paper by Sir Stopford Brunton on "The Gold Deposits of Nova Scotia." This is an analysis of the history and present status of the deposits and a hypothesis concerning the structural features of the province in relation to the deposition of gold. The gold-mining industry in Nova Scotia is dormant and practically nothing is known concerning the economic possibilities of the deposits. It is felt that the field is well worth spending some money on for development.

New South Wales Mineralogy—Mineral Resources Bulletin No. 34 of the Geological Survey, Sydney, New South Wales, by George Smith, is a descriptive mineralogy of the principal occurrences within the state, also dealing with the natural groupings or associations of the minerals themselves. It is of 145 pages and may be obtained for 3s. 3d.

South Australian Mining—The South Australia Department of Mines has issued its semi-annual Mining Review, No. 43, for the half year ended Dec. 31, 1925, describing mining operations in that province. The most important products were iron ore, salt, gypsum, limestone, and copper. Copies of this 82-page bulletin may be obtained on request from the Department of Mines, Adelaide, South Australia.

Graphical Solution of Equations—"The Lightning Graphs," Series 1, (General), by I. S. Dalgleish, has been published in England. These graphs offer a means of instantly solving constantly recurring equations which cannot be solved by an unbroken series of operations on a slide rule. These equations are $a^2 = b^2 + c^2$; $a^n = d$; $\sqrt[m]{a} = d$; $v = \epsilon^x$; and $w = \epsilon^{-x}$. Copies of the book are obtainable for 5s. each from Crosby, Lockwood & Son, 7 Stationers' Hall Court, Ludgate Hill, London, E. C. 4, England.

Economic Geology—The U. S. Geological Survey, Washington, D. C., has recently issued Bulletin No. 780, comprising the following papers, heretofore published separately: "The Melrose Phosphate Field, Montana," pp. 32, by R. W. Richards and J. T. Pardee; "Geology of a Part of Western Texas and Southeastern New Mexico, with Special Reference to Salt and Potash," pp. 94, by H. W. Hoots; "Platinum Near Centennial, Wyo.," pp. 10, by F. L. Hess; and "Antimony and Quicksilver Deposits in the Yellow Pine District, Idaho," pp. 28, by F. C. Schrader and C. P. Ross. The bulletin may be obtained on request.

Chilean Nitrate—The principal technologic features of the Chilean nitrate industry are discussed in a 30-page reprint of an article by Belisario Diaz Ossa, by the International Institute of Agriculture, Rome, Italy. The article is illustrated and in English.

Alaskan Geology—Bulletin 776 of the U. S. Geological Survey, Washington, D. C., is entitled "The Mesozoic Stratigraphy of Alaska," by George C. Martin, pp. 493. Copies are obtainable for 75c. each from the Superintendent of Documents, Washington, D. C. Thick sections of marine Mesozoic strata have been found in many parts of the territory, and are of extreme interest.

Wyoming Oil—U. S. Geological Survey Professional Paper 145, "Geology and Oil and Coal Resources of the Oregon Basin, Meeteetse, and Grass Creek Basin Quadrangles, Wyoming," by D. F. Hewett, pp. 111, has recently been issued. The report is based on field work done from seven to fifteen years ago. Copies may be obtained for $1 each from the Superintendent of Documents, Washington, D. C.

New Machinery and Inventions

Multiple Eccentric Motion in One Revolution of Driven Shaft by New Device

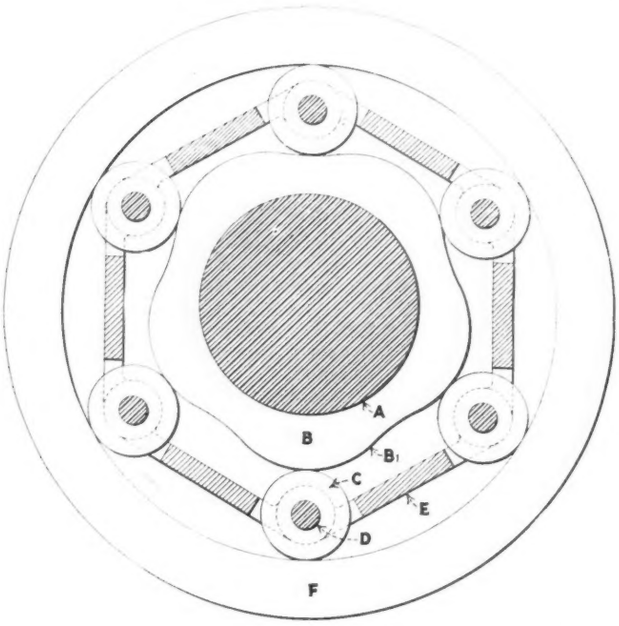


Fig. 1—Diagram showing how multiple eccentric motion is effected

A NOVEL device for procuring any number of eccentric throws per single revolution of a driven shaft, and the practical application of it, has recently been patented. This mechanism is especially interesting in that its field of application may be varied and broad in substituting it to advantage for present ordinary eccentrics.

Referring to Fig. 1, *A* is a shaft, *B* a ring, with a cam periphery B_1; *C* represents rollers which are constantly fixed with relation to one another on pins *D*, which are set in cage *E*. An outer ring is lettered *F*. Shaft *A* may be fixed to ring *B* to revolve with it, or the ring *B* may revolve on shaft *A* as desirable.

In operation of the device to procure multiple eccentric throws ring *B* is revolved by a suitable flexible connection from the driving mechanism similar to that shown in Fig. 2. As *B* revolves, its periphery B_1 rolls on rollers *C*, and since B_1 necessarily advances at practically twice the velocity of rollers *C*, pins *D* and cage *E*, the high and low spots of B_1 must pass over rollers C and by so doing cause *B* and shaft *A* to move radially relative to ring *F*, which is fixed against any movement. Every time that a high portion of B_1 passes over a roller *C* a complete eccentric movement is produced.

Now, by one revolution of ring *B* a number of eccentric motions will be produced and proper variation in the number of rollers *C* and periphery B_1 will govern the number of eccentric motions produced in a single revolution of *B*. It follows that a given number of eccentric motions can be produced by considerably fewer revolutions of *B* than would be required with an ordinary eccentric. The eccentric throw can be increased or decreased as desired by varying contour of B_1 accordingly. The relative velocities of moving parts in the ordinary type of eccentric necessary to produce an equal number of eccentric movements as those produced by the device shown in Fig. 1 would be approximately three times as great. Sliding frictions of an ordinary eccentric are eliminated in this new device because of the roller action. Less heat, less wear, and less power consumption result. Because of the composition of the materials in ring *B* and rollers *C*, and owing to the elimination of sliding friction and the lower velocities, heavy loads may be carried efficiently.

Space permits only a brief description of the practical application of this device.

Fig. 2 is a cross-section of a gyratory type of rock crusher. The crushing head *P* oscillates about a point in spider *Q*. Oscillation is produced by eccentric movement of the extended head *A* in the base. This movement is produced by the device described in Fig. 1 and is accomplished in the following manner:

Driving shaft *S* revolves worm gear *T* through worm *U*. *T* revolves the cam-faced ring *B* on roller *C* through lug *V*. Cage *E*, ring *F* and pins *D* correspond to similar pieces in Fig. 1. Present types of gyratory crushers depend upon an ordinary babbitted eccentric to produce eccentric movement.

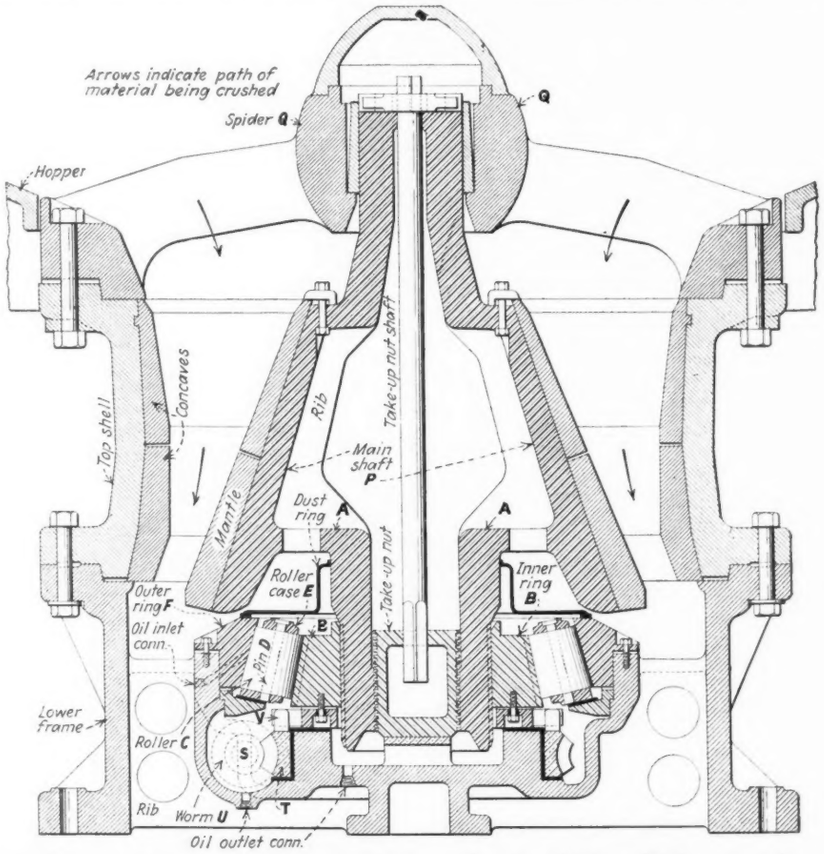


Fig. 2—Cross-section of a gyratory crusher in which multiple eccentric movement is produced by the device shown in Fig. 1

Trade Catalogs

Electrical Supplies. The new No. 20 O-B general catalog is now being distributed by the Ohio Brass Co., Mansfield, Ohio. This book of 945 pages, exceeding the previous edition by 175 pages, includes complete listing of all O-B porcelain insulators, trolley and line materials, rail bonds, car equipment and mining materials. It is logically divided and thumb-indexed for the well-defined classes of products of this company. In addition to descriptive and listing information, there are many helpful suggestions for the man concerned with the installation of these products.

The book is carefully indexed and convenient cross-references are plentiful.

The Market Report

Heavy Lead Sales Feature Metal Markets

Copper Much Quieter and Silver Prices Hit New Low

New York, Oct. 20, 1926—The only really active sellers in the non-ferrous metal markets in the week ending today were the lead producers, practically all of whom report unusually heavy business, some of which was stimulated by price concessions. Zinc and tin have been in about average demand, and copper has had a quiet week, especially in the last three days. Silver took a violent dip to a new low of 51⅛c.

Little Interest in Copper

Only a moderate interest has been taken in copper in the week ending today. The firmness attendent upon the announcement of the export plans has been well maintained in the export market, but domestic prices, after advancing to as high as 14.20c., delivered in the East, have receded to 14⅛c. or less. Fair business was done in the Middle West on Thursday, Friday, and Saturday, at from 14.25 to 14.375c., Eastern business being booked on the same days at from 14.075 to 14.20. Since then but little copper has been sold, chiefly at 14⅛c. delivered in the East, at which price copper could be obtained from most any producer, though there is little pressure to sell. Today, some concessions were made, though no actual sales less than 14.10c. have been reported. Most of the business has been for November-December, though a little was prompt shipment.

Daily Prices of Metals

Oct.	Copper N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
14	13.95	69.75	71.50	8.35	8.075	7.30@7.35
15	13.95	70.00	71.75	8.35	8.10	7.35
16	13.90	69.50	71.50	8.35	8.10	7.35@7.375
18	13.90	69.00	70.50	8.35	8.00@8.10	7.35@7.375
19	13.90	68.875	70.50	8.35	8.025	7.325@7.35
20	13.90	67.875	69.375	8.35	8.00	7.30
Av.	13.917	69.167	70.854	8.350	8.058	7.340

The prices correspond to the following quotations for copper delivered: Oct. 14th and 15th, 14.20c.; 16th, 18th, 19th and 20th, 14.15c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Oct.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
14	59⅜	60¼	66½	318¾	306¼	31¼	31	34½	34 5/16
15	59⅜	60¼	66½	321	308¼	31 3/16	31 9/16	34⅝	34½
18	58⅞	59⅝	66½	315	303¼	31 3/16	31	34 7/16	34 5/16
19	58¾	59⅝	66½	314½	305⅝	30 15/16	30⅞	34 7/16	34 5/16
20	58¼	59⅛	66½	311¼	302½	30⅝	30⅝	34¼	34⅛

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold London	Oct.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
14	4 84 5/8	55¼	25 13/16	84s11½d	18	4 84⅝	52	24 3/16	84s11½d
15	4 84¾	54	25⅛	84s11½d	19	4 84½	51½	24⅛	84s11½d
16	4 84⅝	54	25	....	20	4 84¼	51⅞	24⅛	84s11½d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Lead Cut to 8c., St. Louis

Exceptionally heavy lead business has been booked by practically all sellers, especially for delivery in the Middle West. One producer made attractive concessions in price to attract consumers and was successful in selling a lot of lead, though his supply is by no means exhausted. Another large producer has booked about all he cares to at present levels and is not disposed to follow the market down to its ultimate bottom. Most of the business in the East has been booked at the contract price of the American Smelting & Refining Co., which continues at 8.35c., New York. It has been possible, however, to secure lead for deliveries at other consuming points in the East, besides New York, at or very close to this level. In the last three days a good tonnage of lead has been sold at 8c. flat, St. Louis, though this price cannot be said to be general, and is not quoted for small lots. Storage-battery manufacturers have been particularly active buyers, specifying increased tonnages under average price contracts. November lead has been in somewhat greater demand than October; only two orders for December lead are reported.

Zinc Shows Little Change

Zinc has sold in slightly better volume than last week, galvanizers taking moderate tonnages for both October and November shipment. Prices advanced for two or three days, 7⅜c. having been secured on two or three sales on Saturday, but since then, with lower prices cabled from the other side, have receded to the level of a week ago. High-grade is unchanged at 9¼@9½c., delivered in the East.

Spot Tin Drops Below 70c.

The tin market has been moderately active for deliveries in November and December, with an occasional fancy price paid for prompt. Prices as high as 72c. for spot were paid, but today the price reverted below 70c. for the first time this month. Forward deliveries have commanded about 3c. less.

Silver Drops to 51½c.

During the last week fluctuations in silver have been caused by selling from China and the Continent and by buying from India, although even India has offset spot purchases to some extent by future sales. Selling predominated, however, and as a result the lowest price since Nov. 20, 1915, was established—51½c. in New York on Oct. 19, and 24⅛d. in London on Oct. 20. On the former date London quoted spot 24 5/16d., an overnight advance of ⅛d., caused by Indian buying orders, but after the "fixing" large sellers came forward and London was offering silver in New York at under their quotations for both spot and future delivery. This weakness reacted upon the local market, so that business for New York delivery was executed at 1c. under the net parity of the London spot rate. The decline was overdone, however, for New York advanced on the 20th in spite of the decline of 1/16d. in London.

The market appears steady at the moment, but the future tendency is uncertain.

Mexican Dollars (old Mexican pesos): Oct. 14th, 42c.; 15th and 16th, 41c.; 18th, 39½c.; 19th, 39⅛c.; 20th, 39⅜c.

Lire Advance Further

The feature of the foreign exchange market has been the continued advance of Italian lire. Closing cable quotations on Tuesday, Oct. 19, were: francs, 2.93c.; lire, 4.235c.; and marks, 23.8075c. Canadian dollars, 3/32 per cent premium.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Both 98 and 99 per cent grades quoted at 27c. per lb. London, £107 per long ton for domestic metal.

Antimony—Per lb., duty paid, New York: Chinese brands, spot, 14@14¼c.; November 14⅛c.; December 14⅛c. Cookson's "C" grade, 17¾@18c. Some improvement. Needle and oxide nominally unchanged from quotations in the Oct. 9 issue.

Bismuth—Per lb., New York, in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., New York, 60c. London, 1s. 10½d. for American metal; 1s. 9d. for Australian metal.

Iridium—Per oz., $125@$135 for 98 @99 per cent. Firm. London, £40@ £45 in iridio-platinum; £30@£35 for sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton according to quantity.

Osmium—Per oz., $60@$65. London, £17@£20.

Palladium—Per oz., $68@$70. Pure metal as a constituent of crude platinum, $55@$60 per oz. London £12@ £15, nominal.

Platinum — Official price on refined metal, $112 per oz. Open market cash sales of large lots, $107. Pure metal as a constituent of crude platinum, $106.

London, £23½ per oz. for refined and £21@£22 for crude.

Quicksilver — Per 75-lb. flask, $97 @$98. San Francisco wires $95.33; steady. London, £16½.

Ruthenium—Per oz., nominally $50@ $60. London, £12@£15.

The prices of **Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Radium, Rhodium, Selenium, Tantalum, Tellurium, Thallium, Tungsten,** and **Zirconium** are unchanged from the issue of Oct. 9.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 28@30c. Caucasian (washed), 53@55 per cent, 32c., nominal. The market is purely nominal with no current sales.

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian and Cuban, $70@$80 per ton in carloads.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $10.50@$10.75; Western scheelite, $11@$11.25. Fair activity.

Chrome, Iron, Molybdenum, Tantalum, Uranium, and **Vanadium Ores** are unchanged from quotations in the Oct. 9 issue.

Zinc Blende Advanced; Lead Ore Lowered

Joplin, Mo., Oct. 16, 1926.

Blende	Per Ton
High	$52.80
Premium blende, basis 60 per cent zinc	$50.00@51.00
Prime Western, basis 60 per cent zinc	49.00
Fines and slimes, 60 per cent zinc	48.00@45.00
Average settling price, all zinc	47.96
Galena	
High	$109.70
Basis 80 per cent lead	105.00@102.50
Average settling price, all lead	107.97

Shipments for the week: Blende, 15,045; calamine, 59; lead, 2,920 tons. Value, all ores the week, $1,038,890.

Buyers of lead announce bids on a basis of $102.50, while sellers announce that offers are freely made on a basis of $105 per ton. Sellers insistently declare that $107.50 was paid last week, when buyers were quoting the price as $105 basis.

After lowering the basis of Prime Western last week to $48, buyers advanced offerings to $49 basis this week and were able to purchase 1,000 tons more than the estimated production of this week. Flood conditions have lowered the production to less than 16,000 tons per week, creating a drainage problem, at first thought light, that is taxing present pumping capacity to the utmost to prevent water rising, while headway is very slow in lowering a water level too high in a number of mines to admit of economic mining.

Platteville, Wis., Oct. 16, 1926

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$50.75
Lead Ore	
Lead, basis 80 per cent lead	$110.00

Shipments for the week: Blende, 1,096 tons; lead, 40 tons. Shipments for the year: Blende, 44,024; lead, 1,606 tons. Shipments for the week to separating plants, 2,228 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fuller's Earth, Fluorspar, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystals, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the Oct. 9 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3½c. per lb. for deliveries up to July, 1927. London, £13 per long ton.

Calcium Molybdate, Copper Sulphate, Sodium Nitrate, Sodium Sulphate (Salt Cake), and **Zinc Oxide** are unchanged from prices in the Oct. 9 issue.

Ferro-Alloys

Ferromanganese — Domestic, 78@82 per cent, $88@$90 per long ton, furnace, prompt and future. Spiegeleisen unchanged from Oct. 9 issue.

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from prices in the Oct. 9 issue.

Metal Products

Rolled Copper — Sheets, 22¾c.; wire, 16¼c. per lb., f.o.b. mill.

Lead Sheets—Full rolled, 12¼c. per lb.; clipped, 12½c.

Nickel Silver—29¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal — Dimension sheets, 20¼c. per lb.; rods, 17¼c. per lb.

Zinc Sheets — 11¾c. per lb., f.o.b. works.

Refractories

Fireclay Brick, Chrome Brick, Magnesite Brick, Silica Brick and **Zirkite** are unchanged from quotations in the Oct. 9 issue.

Steel Strong—Pig Iron and Coke Quiet

Pittsburgh, Oct. 19, 1926

There are few spots in which the steel market has grown more active this month as compared with September; in several it has grown less active, and in other branches of the industry the arrival of winter will bring lessened activity.

Steel prices hold very well, and in spots are stronger, advanced prices being in effect in sheets, while bars and shapes are on the whole about $2 a ton higher than five or six months ago.

Pig Iron—Demand for Valley iron continues light, but is slightly improved over a month ago. Bessemer, $19; basic, $17.50; foundry, $18@$18.50, f.o.b. Valley furnaces.

Connellsville Coke—The turnover is very light, prices remaining at $3.50@ $3.75 for spot furnace and $4.25@$4.75 for spot foundry. On account of the strong coal market, any increased coke demand would be met only by higher prices.

Company Reports

McIntyre Has Best Year

R. J. Ennis, general manager for the McIntyre Porcupine Mines, Ltd., mining gold ores in the Porcupine area in Northern Ontario, reports a gross bullion production of $3,804,744.90 and a net profit of $1,721,382 for the year ended June 30, 1926. This is the largest production yet attained by the company. The per-ton recovery was $8.25 against an average during the life of the property of $9.21. Bullion shipped contained 182,631 oz. of gold and 44,833 oz. of silver.

Development

No sinking was done in the two working shafts during the period. No. 5 is 2,435 and No. 6, or main shaft, is 3,019 feet in depth.

The tonnage of ore milled was 60,000 tons in excess of the previous year and taxed the working shafts to the limit, curtailing development work on the lower levels. As pointed out in last year's report, this condition will be relieved upon the completion of No. 11 shaft.

No. 3 Vein—This vein was located on the 1725 and opened up for 810 ft. in ore, assaying $11 over 8 ft. On the 2,000 level 215 ft. of drifting was in ore of $8 grade over 12 ft. Diamond drill holes have intersected the vein on the 1625 and a large tonnage of good ore is expected from this orebody above the 1625 and below the 2000. Stopes produced 27,445 tons of ore averaging $9.80 per ton.

No. 5 Vein—Stopes produced 65,308 tons of ore of an average value of $9.30 per ton. Diamond drilling has not disclosed any large additions to these orebodies.

No. 7 Vein—Production amounted to 237,005 tons of ore averaging $8.70 per ton. On the 1875 and 2000 levels 210 and 250 ft. of advance was made to the west in ore of $9.10 grade over 8.5 ft. On the 2500 the vein has been opened up a distance of 960 ft. assaying $10.50 over 8 ft. Fourteen hundred and eighty feet of drifting on the 2625 shows 1120 ft. of $12.00 ore over 8.5 ft.

No. 8 Vein—Extension to the vein was opened up on the 1625 and 1750. Stopes continue to yield a small tonnage of average grade ore.

No. 9 Vein—This vein produced 83,053 tons of ore of an average value of $10.70 per ton. On the 1375, 1500 and 1725 advances to the east were made in ore below average grade. On the 2500 the vein was opened up for 200 ft. in $9.20 ore over 8 ft.

No. 10 Vein—Development work in this vein on the 1750, 2000 and 2250 opened up a large tonnage of ore under $6. On the three lower levels the vein is in the basic schist in close proximity to the quartz porphyry and has not improved in grade. When No. 11 shaft is completed development work can be carried on more energetically and the result is expected to compare favorably with the results obtained from No. 7 and No. 9 veins.

In No. 11 shaft a vein was intersected at a depth of 2250 ft. dipping to the north and passing out of the shaft at 2375. It is a strong vein assaying $17.20 over 6.5 ft. for the distance exposed.

Estimated Ore Reserves

	Tons	Assay	Value
McIntyre claims	605,448	7.60	$4,612,372.00
McIntyre extension claims	203,449	11.00	2,245,362.00
Jupiter claims	304,269	10.70	3,277,620.00
Plenaurum claims	14,818	10.70	159,084.00
Broken ore in stopes	315,127	8.70	2,743,603.00
	1,443,111	9.00	$13,038,041.00

In the estimate of ore reserves allowance has been made for the dilution of broken ore by wall rock.

Milling

Bowl classifiers have been installed to operate in closed circuit with regrinding tube mills, which has improved the metallurgical results and reduced grinding costs. Three American disc type filters have been installed to follow the counter current decantation system and have made a reduction in dissolved losses.

Operating Costs

Mining:	Total	Per Ton
Exploration	$30,417.63	0.0660
Development	277,554.45	0.6022
Breaking and stoping	1,102,663.61	2.3924
Examination of prospects	12,367.22	0.0268
	$1,423,002.91	$3.0874
Crushing and transportation	$66,117.41	0.1435
Milling	383,545.63	0.8322
Heating and maintenance—buildings and camps	52,560.68	0.1140
Mercantile store and welfare expenses	6,792.70	0.0147
Management, bullion marketing and general expense —mine office	79,831.67	0.1732
Administration and general expense—head office	92,005.08	0.1996
Insurance—general	17,466.46	0.0379
	$2,121,322.54	$4.6025

No. 11 Shaft

No. 11 shaft was continued from 952 to 2,936 ft.—a distance of 1,984 ft. Stations have been cut 250 ft. apart from 1,250 to 1,750 and 125 ft. apart from 1,750 to 2,875. Connection has been made with the No. 6 shaft workings on the 1,875 and 2,375. The objective of 4,000 ft. will be reached in March, 1927, and the shaft put into operation in June, 1927. Foundations are now being placed for hoisting machinery and headframe.

Profit and Loss Statement, July 1, 1925, to June 30, 1926

Earnings, bullion recovery	$3,804,774.90
Total operating costs—before providing for taxes and depreciation	2,121,322.54
Operating profit—before providing for taxes and depreciation	1,683,452.36
Non-operating revenues	104,444.15
	$1,787,896.51
Appropriations: provision for municipal, provincial and dominion taxes for current year	66,514.00
Net profit for the year—before depreciation provision—transferred to surplus account	$1,721,382.51

The Russian Manganese Concessions

More light on the difficulties attending the Harriman manganese operations in Russia is contained in the Riga correspondence in the London *Statist* of Oct. 2. The subject was mentioned editorially in the Oct. 16 issue of *E. & M. J.*

Far more interesting than all else, says the correspondent of *The Statist*, and a matter concerning which much will be heard hereafter, is the ambitious project of the French Government to obtain, for its industrial interests, possession of the manganese fields of Chiaturi and Sharaponi, which for some two years or so have been in possession of the Harriman American company. This surprising piece of information is thus explained: Before the establishment of the Soviet republic the French had invested largely in the Russian manganese properties. In common with those of other nations, their concessions were confiscated on the inception of the new régime. These concessions were of high importance to the great French iron and steel enterprises. When the Harriman Chiaturi concession was granted, the French Government of the day, at the instance of the previous French concessionaires, protested powerfully but without effect. Since then the picture has distinctly changed. The Harriman company has failed to live up to its obligations of output as per contract. On that account the Soviet has the right, if it sees fit, to annul the concession. This legal right might have been overlooked, seeing that the Americans have paid the export duties upon the stipulated minimum output. But now, with the French spurring them on, and dangling before them the tempting promise of a loan—so urgently needed as to be almost a matter of life and death for the nation—the leaders of the Soviet appear ready to exercise their legal rights and expropriate the American company.

The French on their side have announced that a powerful consortium, including the Société des Forges and the Creusot company, are prepared forthwith to take up the Harriman concession with all the onerous conditions attached thereto, conditions which the Harriman group has found it so far impossible to live up to. In support of their plea that the Chiaturi concession be turned over to them the French argue that in the course of the two years during which the Harriman interests have been at work in Georgia the price of the ore has been doubled, whereas the output has not only not been increased but has diminished. They openly charge Mr. Harriman with utilizing his position as monopolist of manganese ore to limit output in order to give time for the development of his manganese mines in Mexico.

Mining Stocks—Week Ended October 16, 1926

Stock	Exch.	High	Low	Last	Last	Div.
COPPER						
Anaconda	New York	49½	46⅝	47⅛	Oc.16, No.22 Q	0.75
Arcadian Consol.	Boston	....	....	*90	....	....
Ariz. Com'l	Boston	10⅛	9⅛	9⅜	Jy. 16, Jy. 30	0.50
Calaveras	N. Y. Curb	....	....	1⅜	....	....
Calumet & Arizona	New York	67⅜	65⅛	65⅛	Se. 4, Se. 20 Q	1.50
Calumet & Hecla	Boston	16⅜	16	16⅛	Au.31, Se.15	0.50
Cerro de Pasco	New York	65	63	63	Jy. 15, Au.2, Q	1.00
Chile Copper	New York	32⅜	31⅛	32	Oc.14, No.1, Q	1.00
Chino	New York	24⅞	24⅞	24⅞	....	....
Con. Coppermines	N. Y. Curb	2⅞	2⅞	2⅞	....	....
Copper Itange	Boston	15¼	14	14¼	May, 1925	1.00
Crystal Copper	Boston Curb	*39	*30	*32	....	....
East Butte	Boston	2⅜	2⅛	2⅛	Dec., 1919	0.50
First National	Boston Curb	...	...	*12	Feb., 1919	0.15
Franklin	Boston	....	....	*40	....	....
Granby Consol	New York	32⅛	29⅜	30⅛	May, 1919	1.25
Greene-Cananea	New York	21⅛	20⅜	21	Nov., 1920	0.50
Hancock	Boston	....	....	1	....	....
Howe Sound	New York	42⅛	40⅛	40⅞	Oc.1, Oc.15 Q	1.00
Inspiration Consl.	New York	26⅜	24⅛	26	Se.16, Oc.4, Q	0.50
Iron Cap	Boston Curb	4	3⅜	3⅜	....	....
Isle Royale	Boston	....	....	11⅛	Jn. 1, Jn. 15	0.50
Jerome Verde Dev	N. Y. Curb	*45	*45	*45	....	....
Kennecott	New York	62⅛	59⅞	60⅛	Sept. 3, Oct. 1 Q	1.00
Lake Copper	Boston	....	....	*80	June, 1925	0.50
Magma Copper	New York	38⅛	36⅛	37⅛	Oc.1, Oc..15, Q	0.75
Mason Valley	N. Y. Curb	2⅛	2⅛	2⅛	....	....
Mass Consolidated	Boston	....	....	*30	Nov., 1917	1.00
Miami Copper	New York	17⅜	16⅜	17	No.1, No.15 Q	0.37½
Mohawk	Boston	45	40⅜	45	Oc.30, De.1 Q	2.00
Mother Lode Coa	New York	5⅞	5⅛	5⅜	Jn. 15, Jn. 30 Q	0.37½
Nevada Consol	New York	15⅛	14⅛	14⅜	Oc.14, Nov.16	0.25
New Cornelia	Boston	22⅜	21	22⅛	Au.6, Au.23 Q	0.40
North Butte	Boston	3⅛	3	3	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*45	*45	*45	Se. 1, Se. 15	0.05
Old Dominion	Boston	....	....	17⅛	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†135	†130	....	Se.25, Oc.2 Q	1.50
Quincy	Boston	....	....	18½	Mar., 1920	1.00
Ray Consolidated	New York	15⅜	15	15⅛	Ap.20, Ap.30	0.25
Ray Hercules	N. Y. Curb	....	....	11⅞	....	....
St. Mary's Min. Ld.	Boston	27⅛	27	27⅛	Ap.17, My.18	2.00
Seneca Copper	New York	4⅛	4⅛	4⅛	....	....
Shannon	Boston	....	....	*40	Nov., 1917	0.25
Shattuck-Denn	Boston Curb	6	5⅜	6	....	....
Superior & Boston	Boston	....	....	*35	....	....
Tenn. C. & C.	New York	11⅜	11	11⅛	Au.31, Se.15, Q	0.25
United Verde Ex	N. Y. Curb	25⅛	25⅛	25⅛	Oc.16, No.1, Q	0.75
Utah Copper	New York	....	....	106½	Se.3, Se.17 Q	1.75
Utah Metal & T	Boston	1⅞	1⅝	1⅝	Dec., 1917	0.30
Victoria	Boston	....	....	*50	....	....
Walker Mining	Salt Lake	*76	*65	*65	....	....
NICKEL-COPPER						
Internat. Nickel	New York	35⅞	35	35⅛	Se.7, Se.30, Q	0.50
Internat. Nickel, pfd.	New York	...	...	103	Oc.14, No.1,	1.50
LEAD						
Gladstone M. M. Co.	Spokane	*30	*29½	*29½	Sept., 1926	0.005
National Lead	New York	150	146	147	Sept., 1926 Q	2.00
National Lead pfd.	New York	116	116	116	Sept., 1926 Q	1.75
St. Joseph Lead	New York	40	39	39¾	Sept., 1926 QX	0.75
ZINC						
Am. Z. L. & S	New York	...	...	6½	May., 1917	1.00
Am. Z. L. & S, pfd.	New York	34⅛	30	30½	Nov., 1920	1.50
Butte C. & Z	New York	5	4⅜	4⅜	De.10, De.24	0.50
Butte & Superior	New York	11⅛	9⅛	10⅛	Se.15, Se.30 Q	0.50
Callahan Zn-Ld	New York	2	1⅞	1⅞	Dec., 1920	0.50
Eagle-Picher	Cincinnati	30⅜	30⅛	30⅛	Au.14, Se.1 Q	0.40
Eagle-Picher, pfd.	Cincinnati	....	....	110	Se. 30, Oc. 5 Q	1.50
New Jersey Zn	N. Y. Curb	....	....	191	July 20, Aug. 10 Q	2.00
United Zinc	N. Y. Curb	....	....	*70	....	....
Yellow Pine	Los Angeles	....	....	*15	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	1	1	1	....	....
Argonaut	Toronto	*46	*38	*42½	....	....
Barry-Hollinger	Toronto	*74½	*64½	*72	....	....
Carson Hill	Boston	25	21½	21½	....	....
Consol. W. Dome L.	Toronto	*24	*22½	*22½	....	....
Cresson Consol. G.	N. Y. Curb	2¼	2¼	2¼	July, 1926	0.10
Crown Reserve	Toronto	*9	*9	*9	Jan., 1917	0.05
Dome Mines	New York	9⅜	9	9	Se.20, Oc.30, Q	0.50
Golden Center	N. Y. Curb	2	1⅞	1⅞	....	....
Golden Cycle	Colo. Springs	....	....	2	Dec., 1925	0.03
Hollinger Consol.	Toronto	19.00	18.75	18.75	Oc.19, No.4 M	0.10
Homestake Mining	New York	63	62½	63	Oc.20, Oc.25 M	0.50
Kirkland Lake	Toronto	1.10	*96½	*97	....	....
Lake Shore	Toronto	14.20	13.75	13.80	Se.1, Se. 15 Q	0.10
McIntyre-Porcupine	New York	23⅜	22⅛	22⅛	No.2, De.1 Q	0.25
Newray	Toronto	....	....	*42	....	....
Noranda	N. Y. Curb	19⅜	18⅛	18⅛	....	....
Night Hawk Pen	Toronto	*6	*5	*5	....	....
Portland	Colo. Springs	...	....	*43	Oc.6, Oc.15	0.02
Rand Mines	New York	....	....	41⅜	Au.23-30 Am.Sh.	1.52
Teck-Hughes	Toronto	4.90	4.58	4.72	Jy. 15, Au. 2	0.05
Tom Reed	Los Angeles	*55	*55	*55	March, 1926	0.02
Tough-Oakes	Toronto	*47⅞	*42	*42	....	....
United Eastern	N. Y. Curb	*50	*50	*50	July, 1924	0.05
Vipond Cons	Toronto	1.74	1.70	1.71	....	....
Wright-Hargreaves	Toronto	8.60	8.30	8.30	Se.15, Oc.1 QX	0.07½
Yukon-Alaska Trust	N. Y. Curb	....	....	20	....	....
GOLD AND SILVER						
Carnegie Metals	Boston	....	....	13½	....	....
Con. Cortez	N. Y. Curb	....	....	*5	....	....
Con. Virginia	San Francisco	*6½	*5½	*5½	....	....
Continental Mines	N. Y. Curb	....	....	*48	....	....
Dolores Esperanza	N. Y. Curb	*65	*60	*60	July, 1923	0.05
Premier Gold	N. Y. Curb	2⅛	2	2⅛	Se.15, Oc.4 Q	0.08
Tonopah Belmont	N. Y. Curb	2⅛	2⅛	2⅛	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*35	*25	*35	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	4 5/16	4⅛	4⅛	Se.30, Oc.27 Q	0.07½
Unity Gold	N. Y. Curb	....	....	*30	....	....
West End Consol.	N. Y. Curb	*16	*12	*16	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	*30	*30	*30	June, 1918	0.02

Stock	Exch.	High	Low	Last	Last	Div.
SILVER						
Alvarado	N. Y. Curb	....	....	1	Oct., 1920	0.50
Beaver Consol	Toronto	*84	*77	*78	May. 1920	0.03
Castle-Trethewey	Toronto	1.21	1.01	1.05	....	....
Coniagas	Toronto	4.45	4.00	4.05	May, 1924	0.12½
Keeley	Toronto	1.51	1.41	1.45	Se. 1, Se.15 SA	0.12
Kerr Lake	N. Y. Curb	*90	*90	*90	Oc.1, Oc.15	0.12½
La Rose	Toronto	*7⅛	*7⅛	*7⅛	Apr., 1922	0.10¼
Lorrain Trout Lake	Toronto	....	....	*55	Jy. 2, Jy. 15	0.05
McKinley-Dar.-Sav	Toronto	*10½	*9	*9½	Oct., 1920	0.03
Mining Corp. Can	Toronto	2.91	2.65	2.68	Jy.1, Jy.15 SA	0.12½
Nipissing	N. Y. Curb	5⅛	5⅛	5⅛	Se.30, Oc.20 Q	0.15
Temiskaming	Toronto	....	....	*8	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	6⅞	6⅛	6⅛	Se.28, Oc.1, QX	0.25
Alta Merger	Salt Lake	†*4	†*1½	....	....	....
Bingham Mines	Boston	6	5	5	Se.20, Se.30 Q	1.00
Cardiff M. & M	Salt Lake	....	....	*31	Nov., 1924	0.10
Chief Consol	Salt Lake	....	....	2.75	Oc.10, No.1 Q	0.10
Consti'n Mng. & Mill'g	Spokane	*50	*50	*50	....	....
Emma Silver	Salt Lake	†1	†*75	...	....	....
Erupcion	Boston Curb	1⅛	1	1	Se.25, Oc.1, QX	0.10
Federal M. & S	New York	87	87	87	....	....
Federal M. & S., pfd.	New York	72⅜	71½	71½	Au.25, Se.15 Q	1.75
Hawthorne Mines	N. Y. Curb	*12	*11	*11	....	....
Hecla Mining	New York	17⅛	15½	15½	Au.14, Se.15 Q	0.50
Highland-Surprise	Spokane	*21	*21	*21	....	....
Iron King Mining	Salt Lake	*25	*24	*24	....	....
Keystone Mining	Salt Lake	*28	*28	*28	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16	*15	*15	....	....
Lucky-Tiger Com	Kansas City	†8.10	†7.95	...	Oc.10, Oc.20 X	0.07
Mammoth Mining	Salt Lake	....	....	2.70	Mar.24, Apr. 1	0.10
Marsh Mines	Spokane	3.12½	2.25	3.12½	Se.15, Oc.19	0.15
Park Utah	New York	5.60	5.30	5.40	Se.15, Oc.1 Q	0.15
Plutus Mining	Salt Lake	2	2	2	Oct. 15	0.15
Prince Cons	Salt Lake	....	....	3	....	....
Silver King Coal	Salt Lake	7.50	7.40	7.40	Se. 20, Oc.1,	0.25
Silversmith	Spokane	*44	*35½	*36½	Oc.1, Oc.10 Q	2.00
Strattons Mines	Spokane	*42½	*41	*41	....	....
Tamarack-Custer	Spokane	*25	*23	*25	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.75	10.25	10.50	Se.13, Se.25 QX	0.40
Utah-Apex	Boston	6	5⅞	5⅞	Oc.3, Oc.15 Q	0.25
Western Utah Copper	N. Y. Curb	....	....	*5	....	....
IRON						
Bethlehem Steel	New York	47	44⅛	44⅞	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	80	79	80	Oct., 1926	1.00
Colorado Fuel & Iron	New York	44⅜	41⅛	41⅛	May, 1921	0.75
Gt. North'n Iron Ore	New York	19⅜	19⅛	19⅛	Dec., 1925	0.75
Inland Steel	New York	40	39⅜	39⅞	Au.13, Se.1 Q	0.62½
Mesabi Iron	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Replogle Steel	New York	9⅜	9	9	....	....
Republic I. & S	New York	57⅛	54⅛	54⅜	Au.14, Se.1	1.00
Republic I. & S. pfd.	New York	...	...	96⅜	Se.15, Oc.1 Q	1.75
Sloss-Sheffield S. & I.	New York	126	119	119	Se.10, Se.20	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	....	....	104½	Se.20, Oc.1 Q	1.75
U. S. Steel	New York	144⅛	136⅛	136⅝	Se.2, Se.29 Q	1.75
U. S. Steel pfd	New York	128	127⅛	127⅛	Au.3, Au.30, Q	1.75
Virginia I. C. & C	New York	48	48	48	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York	...	....	72	Jn.1, July 2 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM						
De Beers Consol	New York	38⅜	38⅜	38⅜	Ju.16, Ju.17	1.70
So. Am. Gold & P	N. Y. Curb	4⅛	4⅛	4⅛	....	....
Alum. Co. of Amer	N.Y.Curb	78¾	70	70	....	....
Alum. Co. of Amer pf.	N.Y.Curb	....	....	102	June 15, July 1, Q	1.50
Vanadium Corp	New York	38⅛	36⅛	36⅛	Au.2, Au.16, Q	0.75
ASBESTOS						
Asbestos Corp., New	Montreal	21	19⅜	21	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	76	72½	74	Jy.1, Jy.15, SA	1.75
SULPHUR						
Freeport Texas	New York	29⅜	27⅛	27⅜	Nov., 1919	1.00
Texas Gulf	New York	43¼	41⅛	41⅛	Se.7, Se. 15, Q	3.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	48	46⅛	48	Au.20, Se. 1, Q	1.00
Amer. Metal pfd	New York	....	....	114	Au.21, Se. 1 Q	1.75
Amer. Sm. & Ref	New York	134⅛	128⅛	128⅛	Oc.15, No.1, Q	2.00
Amer. Sm.&Ref.pfd.	New York	120	119⅜	120	No.5, De.1, Q	1.75
Consol. M. & S	N. Y. Curb	...	....	300	Jn.30, Jy.5 SAX	3.75
Federated Metals	N. Y. Curb	....	....	12	....	....
Newmont Mining	N. Y. Curb	77	72	75	Oc.1, Oc.15,	0.60
Southwest Metals	N. Y. Curb	....	....	1	....	....
U. S. Sm. R. & M	New York	35	33	33	Oc.7, Oc.15, Q	0.87½
U. S. Sm. R.&M.pfd.	New York	47	46	46½	Oc.7, Oc.15, Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Henry Sachs, Colorado Springs, Colo.

PRICE WEEK ENDED CTT. 6, 1926

Name	High	Low	Last		Last Divd. Date	Amount
Aramayo Mines (25 frs.)	80/—	77/6	78/9	Aug.	1926	15 p.c.†
British Platinum (£1)	3/6	2/7½	3/—	Feb.	1925	2½ p.c.
Burma Corpn. (10 rupees)	15/ 9	14/9	15/—	Aug.	1926	7 annas*
Bwana M'Kubwa (5s)	7/3	6/10½	6/10½			
Camp Bird (2s)	4/4½	3/—	3/—			
El Oro (£1)	7/—	6/4½	6/6	Nov.	1924	2½ p.c.*
Esperanza (10s)	—/9	—/7½	—/9			
Frontino & Bolivia (£1)	8/3	8/—	8/3	July	1926	2½ p.c.
Mexican Corpn. (£1)	11/10½	10/—	11/—			
Mexico Mines of El Oro (£1)	22/9	22/6	22/6	June	1926	7½ p.c.*
Oroville Dredging (£1)	3/6	2/9	3/6	Dec.	1923	3¾ p.c.
Ouro Preto (£1)	2/—	1/9	2/—	May	1925	2½ p.c.
Rhodesian Congo Border (£1)	116/3	114/4½	116/3			
St. John del Rey (£1)	8/9	8/3	8/6	June	1925	6¼ p.c.
San Francisco Mines (10s)	34/6	33/3	34/—	June	1926	15 p.c.
Santa Gertrudis (£1)	17/—	14/7½	14/9	Oct.	1926	3½ p.c.
Selukwe (2s. 6d.)	13/10½	13/4½	13/4½	April	1917	6¾ p.c.
S. Amer. Copper (2s.)	3/10½	3/7½	3/10½	Nov.	1917	75 p.c.
Tanganyika (£1)	50/9	45/7½	45/7½	Aug.	1926	7½ p.c.
Tomboy (£1)	3/6	3/4½	3/6	July	1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	11.000	10.250	10.450	July	1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation.